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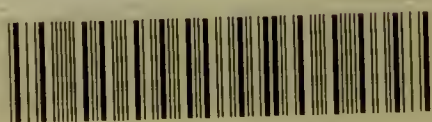
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THE
PRINCIPLES AND PRACTICE
OF
DENTISTRY

INCLUDING
ANATOMY, PHYSIOLOGY, PATHOLOGY, THERA-
PEUTICS, DENTAL SURGERY
AND MECHANISM.

BY
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LATE PRESIDENT OF THE BALTIMORE MEDICAL COLLEGE, AUTHOR OF "DICTIONARY
OF MEDICAL TERMINOLOGY AND DENTAL SURGERY."

Thirteenth Edition.

REVISED AND EDITED BY
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EDITOR'S PREFACE

TO THE

THIRTEENTH EDITION.

THE continued demand for, as well as the exhaustion of, the twelfth edition of this well-known and universally used text-book, has stimulated the author to prepare a new edition with the care demanded by a due consideration of the needs of the dental practitioner and student.

In the preparation of this new edition, every chapter of the entire work has been carefully revised, and, with few exceptions, important additions made to all of them.

By omitting considerable matter that was either obsolete, or more properly belonged to works treating of special as well as kindred sciences, this new edition has been somewhat abridged as to the number of pages, and thereby prevented from becoming unwieldy. In the anatomical portion it was deemed necessary to add to the description of the bones of the jaws that of the entire skull. Many new processes appear in the new edition, and the already large number of illustrations has been greatly increased. Special care has been taken to mention the latest methods for constructing crown- and bridge-work and artificial dentures, and the most approved systems for correcting irregularity of the teeth, fractures of the jaws, etc., etc. Many chapters have been rewritten, and the entire work brought up to the present advanced standard of dentistry in all its branches. The author, therefore, presents this new edition in the belief that it will prove to be more useful even than its predecessors, and meet the requirements expected of a text-book on such subjects as it comprises.

FERDINAND J. S. GORGAS.

HAMILTON TERRACE, BALTIMORE, MD., 1895.

EDITOR'S PREFACE

TO THE

TWELFTH EDITION.

THE reputation and success of this text-book as an elementary treatise on the principles and practice of dentistry have been so apparent, and so universally recognized for many years by the practitioner and student, that no words of commendation on our part need be said. It has reached every civilized country and been translated into several languages.

The rapid advance of dental science, without a parallel when compared with that of other professions, has necessitated repeated additions, until the present volume has attained a size greatly above any that has preceded it.

In presenting the twelfth edition, it is with the hope that the efforts made to render the work such that it may receive the kind approval so generally bestowed upon the editions that have preceded it may be appreciated by those for whose benefit it has been prepared. It is an encouraging fact that the eleventh edition was exhausted some months before the present one was ready to be issued.

Additions have been made to almost every chapter, and new matter added to such an extent that this new edition contains, notwithstanding omissions deemed necessary, some *two hundred and twenty-six* pages more than its immediate predecessor. *Three hundred and eighty-two* new illustrations have also been added and considerable changes made in the general arrangement of subjects, all of which it is hoped will increase its value as a text-book.

A number of systems not before published in works of this character appear in the present volume, and every effort has been made to sustain the reputation heretofore accorded to it by the dental profession.

The editor and publishers are under many obligations to dental practitioners of recognized ability and reputation for systems of practice of which they are the authors; and also to the S. S. White Dental Manufacturing Company, the Welch Dental Company, Samuel A. Crocker & Company, through whose courtesy many of the valuable wood-cuts which appear in the present volume were furnished, and which greatly add to its value as a text-book.

FERDINAND J. S. GORGAS.

HAMILTON TERRACE, BALTIMORE, MD.,

February 1, 1889.

EDITOR'S PREFACE

TO THE

ELEVENTH EDITION.

THE first edition of Chapin A. Harris's "Principles and Practice of Dentistry" was published in 1841, and from that date it has been the principal text-book in all dental schools.

The last or tenth revision was issued under the careful supervision of the late Professor Philip H. Austen, M.D., D.D.S., assisted, in the parts relating to anatomy and physiology, by Dr. Thomas S. Latimer, and in parts relating to pathology and surgery, by the editor of the present edition. As the ten years prior to this revision had nearly revolutionized dental mechanism, Professor Austen found it necessary to almost re-write the portion of the work relating to "Mechanics," and its superior excellence was universally acknowledged.

Nearly fourteen years having elapsed since this was done, the rapid advances made during this period in Dental Histology, Pathology, Surgery, and also to a considerable degree in Mechanism, have necessitated another revision, and at the request of the author's family and of the publishers, the editor has alone undertaken the task of revision, and the present edition is the result of more than a year's labor. This duty has been assumed with the hope that an experience of over a quarter of a century as a teacher in dental schools, and also as a dental practitioner, may have furnished the qualifications for such an undertaking.

The time which has elapsed since the first appearance of the tenth

edition has necessitated a greater revision of this work than has been the case with any former edition, and the task of preparing an entirely new work would have been no greater.

Considerable changes have been made in the general arrangement of subjects; a number of entirely new chapters have been added in the consideration of subjects not even alluded to in former editions; additions have also been made to the text of nearly every chapter, some of the latter being far in excess of the original text.

The number of illustrations has been greatly increased, and the new matter now inserted has brought the work fully up to the time of its publication.

Obsolete theories and processes, together with unimportant details, have been omitted and more useful matter substituted. The aim of the editor has been to meet the demands of the present advanced state of dental science.

The new matter added includes: The Development of the Bones of the Head and Face; Temporo-Maxillary Articulation; Description of Mucous Membrane; The Origin and Development of the Teeth; Analysis of Tooth Structures; Secondary Dentine; Dentition; Calcification and Decalcification of the Teeth; Alveolar Pyorrhea; Aphthous Stomatitis; Thrush; Sanguinary Calculus; Malformed Teeth; Effects of Syphilis upon the Dental Structures; Caries of the Maxillary Bones; Sensitive Dentine; Theories as to the Cause of Dental Caries; Treatment of Dental Caries; New Methods, Materials, and Instruments Employed in Filling Teeth and other Operations; Electric Mouth Lamp; Electric Mallet; Dental Engines and Attachments; Rubber Dam Appliances; Treatment and Appliances for Correcting Irregularity of the Teeth; Contour Fillings; Replantation and Transplantation of Teeth; Different Methods of Inserting Artificial Crowns on Natural Roots; Bridge-Work; General and Local Anesthetic Agents; Improved Forceps; New Materials and Trays for Impressions; Articulators; Blowpipes; Furnaces; Celluloid; New Apparatus for Vulcanizing Rubber and Molding Celluloid; Repairing Vulcanite; Duplicating Dentures; Theory of Vulcanizing; Regulators; Gold Alloy and other Cast Bases; Temperament in Relation to Natural and Artificial Teeth;

Improvements in Porcelain Teeth ; New Splints for Fracture of the Jaws, etc., etc., etc.

The editor desires to acknowledge his indebtedness to Drs. George B. Snow, James H. Harris, Charles L. Steel, W. Storer How, and D. Genese, for valuable suggestions; and also to the writings of Drs. James W. White, Frank Abbott, J. Foster Flagg, John Tomes, Charles Tomes, Henry Sewell, Henry W. Williams, C. N. Peirce, W. D. Miller, G. V. Black, George Watt, J. L. Williams, James B. Dexter, Norman W. Kingsley, Theo. F. Chupein, J. N. Farrar, W. C. Barrett, J. D. Hutchinson, W. G. A. Bonwill, A. W. Harlan, C. T. Stockwell, the late M. A. Dean, M. H. Webb, and others. The courtesy of The S. S. White Dental Manufacturing Company, Johnson & Lund, Snowden & Cowman, Codman & Shurtleff, The Buffalo Dental Manufacturing Company, Spencer & Crocker, Ransom & Randolph, Gideon Sibley, and Dr. Norman W. Kingsley, is acknowledged, for the use of many valuable wood-cuts.

The Eleventh Edition of Harris's "Principles and Practice of Dentistry" is submitted to the profession, with a hope that it will be found a useful elementary treatise, a text-book for the student, and a reliable guide for the dental practitioner.

FERDINAND J. S. GORGAS.

BALTIMORE, *January, 1885.*

PREFACE TO THE SECOND EDITION.

IN submitting to the profession a Second Edition of his Dental Practice, the author is happy to avail himself of the opportunity to express his grateful appreciation of the approbation which the First has received. He trusts that the additions which he has made to the primary work will make the one now presented still more acceptable. The alteration in the plan, which has resulted from the effort at improvement, has, however, rendered a slight change of title necessary, in order to express the character of the present book.

In the First Edition the Anatomy of the Mouth was omitted, because a thorough knowledge of it can be obtained from works on General Anatomy. But it has been suggested that such works may not be at hand when wanted by the dental student, and the author has thought it better to furnish a description of the several structures which enter into the formation of this cavity. He has, however, confined himself to brief expositions of the parts; not wishing to encumber the work, or distract the student with the consideration of matters foreign to the purpose for which it was written, and for which, he trusts, it will be read. He is indebted to Bourger's Anatomy, Quain and Wilson's Anatomical Plates, Wilson's Anatomy, and Smith and Horner's Anatomical Atlas, for a number of the illustrations used in this part of the work.

The Second and Fifth Parts embody the substance of two papers by the author, which were written subsequently to the publication of the First Edition. The subjects of them came properly within the plan of the present work.

The object of the author in the preparation of this edition has been to provide a thorough elementary treatise on Dental Medicine and Surgery, which might be a text-book for the student and a guide to the more experienced practitioner; and he hopes that the modifications he has introduced, and the additions he has made, will entitle it to be so considered, at least, until an abler hand shall prepare a better.

CHAPIN A. HARRIS, M.D., D.D.S.

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THE
PRINCIPLES AND PRACTICE
OF
DENTISTRY.

CHAPTER I.

ANATOMY AND PHYSIOLOGY OF THE MOUTH.

THE mouth (*oral or buccal cavity*) is the entrance to the alimentary canal, and in the human subject signifies the space included between the palatine arch *above*, the mylo-hyoid muscles *beneath*, the lips in *front*, the soft palate and fauces *behind*, and the cheeks on *either side*. The teeth and closed jaws separate the inner portion, or lingual cavity, from the outer, or vestibular space.

The form of the mouth is nearly oval, and it is lined with mucous membrane, which is continuous with the integument at the free margin of the lips, and with the same membrane lining the fauces behind. The mucous membrane of the mouth is naturally of a rose-pink tinge, covered by stratified epithelium, and variable in thickness, being very thick where it covers the hard parts bounding this cavity.

In the mouth are the tongue, teeth, and the alveolar ridges invested by the gums; into it are poured the secretion of the parotid, sub-maxillary, and sublingual glands, as well as that of the ordinary mucous and of the special lingual follicles; and in it the food is subjected to the processes of mastication and insalivation previous to deglutition.

It is further concerned in the prehension of aliment; and besides containing the organs of taste, is employed in articulation, expectoration, suction, etc.

The parts concurring to constitute the mouth form a very complicated piece of mechanism; through them it has a wide range of sympathies, and by them it performs a great variety of functions.

The anatomical elements composing these parts consist of Bone, Ligament, Muscle, Gland, Blood-vessel, Nerve, Areolar and Adipose tissues, and Mucous membrane.

These different elements combine together and form the various organs which constitute the mouth.

These organs will be considered in their physiological order; thus combining their anatomy and physiology, studying at the same time both their healthy structure and function.

CHAPTER II.

OSTEOLOGY.

BONE is one of the hardest substances in the body, and is endowed with a certain degree of toughness and elasticity. Its natural color is pinkish-white externally and red internally. It is composed of animal, or organic, matter, in intimate association with earthy, or inorganic, matter. From the organic matter the bone derives the properties of toughness and elasticity; and from the earthy material, hardness and solidity. The mineral matter may be dissolved out by a dilute solution of nitric or muriatic acids, while the animal matter remains unaffected, retaining its form, though losing its hardness, so that the long bones, so great is their flexibility, may be tied into a knot; on the other hand, by subjecting them to a high heat in an open fire, while exposed to the air, the animal matter may be consumed, leaving the mineral to preserve the form of the bone, but so insecurely that it will crumble to ashes in the grasp of the hand.

The composition of bone, according to Berzelius, is about one-third animal and two-thirds mineral matter:—

Organic, or Animal, Matter,	}	Gelatin and Blood-vessels,	33.30
		Phosphate of Lime,	51.04
Inorganic, or	{	Carbonate of Lime,	11.30
Earthy, Matter.		Fluorid of Calcium,	2.00
		Phosphate of Magnesia,	1.16
		Soda and Chlorid of Sodium,	1.20

The proportion of earthy and animal matter is generally thought

to vary with varying age. According to Shreger, this difference is as follows:—

	<i>Child.</i>	<i>Adult.</i>	<i>Old Age.</i>
Animal Matter,	47.20	20.18	12.2
Earthy Matter,	48.48	74.84	84.1

In childhood, when the animal matter is in excess, the bones, on account of injury, may become bent or partially fractured; whereas in old age, the earthy matter being in excess, the bones are more brittle and fracture more easily.

The local position of bone is first occupied by a mucoid (mucous-like) substance which is transformed into temporary cartilage (*blastema*) during the second month of fetal life. The young bone-cells (*osteoblasts*) are then deposited in the cartilage at certain points, and their deposition and subsequent pressure cause the absorption of the cartilage. This is the form of ossification described as *intracartilaginous*.

In the second form of ossification, described as *intramembranous*, no temporary cartilage (or cartilage mold) precedes the appearance of the bone-tissue. The bones of the vertex of the skull are entirely formed by intramembranous ossification. In the local position of the bone about to be formed, a little network of osseous spiculæ first appears radiating from the point of ossification, which under the microscope consists of fine, clear fibres and granular corpuscles, with an intermediate ground-substance. These fine fibres are termed *osteogenic* fibres, which soon become dark and granular from calcification, and as they calcify they enclose the bone-cells (*osteoblasts*). The calcification includes both the fibres and intermediate or ground-substance in which the former are contained. The number of ossific centers differs: In the long bones there is a central point of ossification for the shaft and one for each extremity.

Bone is composed of an outer compact layer, and an inner cellular or spongy structure, and is surrounded, except at the articular cartilages, by a vascular fibrous membrane termed the *Periosteum*, which envelops the bone and receives the insertions of all tendons, ligaments, etc. The central cavity of the long bones is lined by a structure similar to the periosteum, known as the *Endosteum*.

The Haversian Canals are tunnels in the compact substance of the bone which contain the blood-vessels. Whenever the bone is so thin as to be able to derive its nutrition from the vascular membrane covering its surface, there are no Haversian canals in it, as none are required. Such bones, however, have numerous lacunæ, which send out canaliculi to open on the surface and imbibe the requisite nutrition.

The Haversian canals vary in diameter from $\frac{1}{1000}$ to $\frac{1}{200}$ of an inch,

the average being $\frac{1}{500}$. The smallest are found near the outer surface, where the bone is the most compact, but they gradually become larger toward the interior, where they open out into the spongy or cancellous tissue or into the medullary cavity. The smaller canals contain only a single capillary blood-vessel; the larger contain a network of vessels, while the largest, which gradually merge into the cancellous tissue, contain marrow as well as blood-vessels.

The Lacunæ are the irregular hollow cavities or spaces between the lamellæ, arranged in concentric circles around the Haversian canals. They are characteristic of true bone, and each lacuna contains a soft nucleated substance termed bone corpuscle, which sends its soft processes along the canaliculi. The bodies in the lacunæ and canaliculi circulate nutritious matter through the bone. The lacunæ are commonly oval and flattened, so that one of their broad sides is turned toward the Haversian canal. The lacunæ measure about $\frac{1}{2000}$ of an inch in their long diameter, and about $\frac{1}{6000}$ in their short. *The Canaliculi* are exceedingly minute canals which in their course cross the lamellæ and connect the lacunæ with each other and also with the Haversian Canal. They run off from all parts of the circumference of the lacunæ and communicate most freely with the canaliculi of the adjoining lacunæ. Their diameter ranges from $\frac{1}{14000}$ of an inch to $\frac{1}{20000}$ of an inch, but some are even smaller.

The Lamellæ are the concentric thin plates of bone tissue encircling the Haversian Canal, and result from successive layers of bone being deposited around the Haversian vessel, the one within the other; a process which renders the bone more dense in structure.

CHAPTER III.

BONES OF THE HEAD AND FACE.

ALTHOUGH most of the bones of the human body pre-exist in the shape of cartilage, there are some which are directly formed in membrane, namely, such bones of the skull as the frontal, parietal, the upper half of the occipital, the squamous and tympanic parts of the temporal; also the bones of the face, and the inner plate of the pterygoid process of the sphenoid bone. In fact, none of the bones of the skull pre-exist as cartilage, except those which form the base of the skull. The bones of the head are twenty-two in number, of which eight compose the cranium and fourteen the face. Those of the cranium are one frontal, two parietal, two temporal, one occipital,

one sphenoid, and one ethmoid. Those of the face are six pairs and two single bones; the pairs are the two malar, two superior maxillary, two lachrymal, two nasal, two palatine, and two inferior turbinated. The vomer and inferior maxillary are the two single bones.

Development of the Bones of the Head and Face.—The first definite form which is developed in the embryo is that of the rudimentary spinal column, its earliest trace being a faint streak, which is known as the *primitive trace* or *groove*. This groove deepens into a furrow, which is bounded by two plates, beneath which a delicate fibril appears, called the *chorda dorsalis*, or *notochord*, in which cartilage is very early developed.

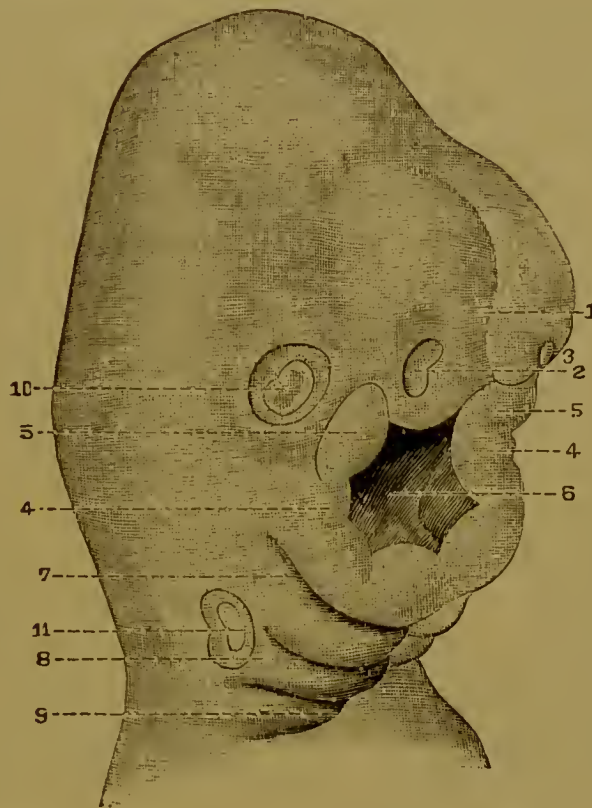


FIG. 1.—FACE OF AN EMBRYO OF 25 TO 28 DAYS. (MAGNIFIED 15 TIMES.)

1. Frontal prominence. 2, 3. Right and left olfactory fossæ. 4. Inferior maxillary tubercles, united in the middle line. 5. Superior maxillary tubercles. 6. Mouth or fauces. 7. Second pharyngeal arch. 8. Third. 9. Fourth. 10. Primitive ocular vesicle. 11. Primitive auditory vesicle.

The upper end of the *chorda dorsalis* terminates in a pointed extremity extending as far forward as the sphenoid bone.

The embryonal cranium is developed from the primitive vertebral discs, which surround the upper extremity of the *chorda dorsalis*. These discs advance in the form of a membranous capsule, which molds itself on the cerebral vesicles, so as to constitute the membrane in which the vault of the skull is developed, and which is replaced by cartilage in the part corresponding to the base of the skull. A portion of this primitive cartilaginous cranium atrophies and disappears, while another portion remains and forms the car-

tilages of the nose and the articulations, the basilar part of the occipital, the greater part of the sphenoid, the petrous and mastoid portions of the temporal, the ethmoid, and the septum nasi.

From the anterior end of the chorda dorsalis the four pharyngeal arches proceed on either side and meet in the middle line.

In these pharyngeal arches the secondary bones are developed, so called to distinguish them from those already referred to, which are formed from the primitive cranium itself. The buccal depression, which afterward becomes the cavity of the mouth, or rather the fauces, is situated between the first pharyngeal arch and the frontal protuberance.

The first pharyngeal arch divides at its anterior extremity into two parts—a superior and inferior maxillary protuberance, the inferior maxillary uniting very early to the corresponding one of the opposite side, to form the lower jaw.

The superior maxillary protuberances are united to the external nasal process, and the palate bone, the superior maxillary, the malar, and also the internal plate of the pterygoid process are developed from this process. From the internal nasal process, the nasal bones, the lateral portions of the ethmoid, and the os unguis are developed. From the incisive tubercle or process, which unites the rest of these processes on either side, and which grows downward from the frontal prominence, filling in the space between the extremities of the two processes which proceed from the first pharyngeal arch, the intermaxillary bone, the middle of the upper lip, and the vomer are formed. When the middle and two lateral processes fail to unite, the deformity known as *hare-lip* is caused. From the lateral processes of the superior maxilla the plates which form the hard palate grow toward each other, union occurring in the median line. This union of the plates separates the nose from the buccal cavity, and is generally completed at the end of the second month. Prior to this union of the plates by their complete development, the nose and buccal cavity form but one cavity; and when this union does not take place the deformity known as *cleft-palate* results. Cleft-palate often accompanies hare-lip, as the causes which produce the latter deformity, during the development of the intermaxillary bones, may prevent the natural development of the palate bones.

At an early period of embryonal life the inferior maxillary arch, which also arises from the first pharyngeal arch, is altogether destitute of any trace of osseous tissue, but it encloses within the elements composing it a symmetrical cartilaginous band, which performs a transitory part only in the development of the jaw.

This band is called “Meckel’s Cartilage,” and it occupies the

interior of the maxillary arch, having the form of a whitish cord situated in a bed of soft transparent tissue, and is composed of two symmetrical parts corresponding to the right and left sides of the lower jaw, which parts soon become united at the mental symphysis. From this point or juncture the two halves extend on either side to the bones of the ear, terminating in the malleus, which, with the incus, is formed from it.

Meckel's cartilage gives form and stability to the lower jaw of the embryo, and is the first solid structure discovered in the maxillary arch. It first appears about the twenty-fifth day, and during its existence, which extends to the fifth month of fetal life, it is subject to constant modifications or transitory states.



FIG. 2.—MECKEL'S CARTILAGE, FROM EMBRYO OF 40 TO 42 DAYS, BEFORE APPEARANCE OF MAXILLARY BONE.

a. Enlargement of cartilage near neck of malleus. *b.* A slightly enlarged portion of cartilage, but contracted at median line, where it unites with that of opposite side. *n.* Handle of malleus. *o.* Cartilage of the os lenticulare. *l.* Cartilage of the stapes. *s.* Outline of the jaw to be formed.

As soon as the cartilage has attained its full development, a period which corresponds to the ossification of the malleus, it begins to disappear, except the end, which extends up to the tympanum and becomes ossified into the malleus, owing to the action of the osteoblasts by which this cartilage is ossified, and becomes a part of the maxilla.

In the upper jaw the period of evolution corresponds with that of the lower jaw; Meckel's cartilage belongs exclusively to the lower jaw.

At a period between the thirty-fifth and fortieth days of embryonal life, slight traces of ossification are observed at points midway between the angle and symphysis of the future jaw, and the ossification extends rapidly in both directions, anterior and posterior, along the external face of Meckel's cartilage, and in contact but not united with it.

At about the second month of gestation, the rudimentary jaw-bone is formed, but not completed; it is composed of two arches, an internal cartilaginous one, composed of Meckel's cartilage; and an external one, composed of osseous matter; the former being only needed for a time to support the jaw, and the latter the rudiment of the bone of the jaw.

While later in life there are two superior maxillary bones, in early fetal life there exists what are called inter-maxillary bones, the upper jaw during its development being composed of four bones—two maxillary and two inter-maxillary. In each of the two inter-maxillary bones are developed two incisors—a central and a lateral, and in each of the two maxillary bones—a canine and two molars—later a canine, two bicuspid, and three



FIG. 3.—FROM HUMAN EMBRYO OF 60 DAYS, NATURAL SIZE.

A. Extra-tympanic portion of Meckel's cartilage. B. Symphysis. N. Handle of malleus.

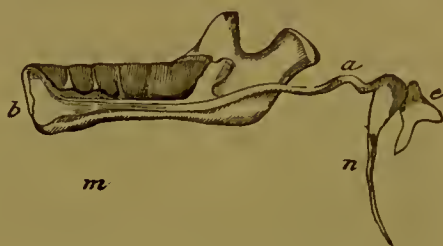


FIG. 4.—INTERNAL FACE OF RIGHT INFERIOR MAXILLA OF EMBRYO OF THREE MONTHS.

a. Extra-tympanic portion. b. Symphysis of the cartilage. n. Handle of malleus. e. Cartilage of incus.

molars. Before birth the intermaxillary and the maxillary bones unite, reducing the number to two instead of four, and the inter-maxillary suture, where the union takes place, can be seen at birth on the palatal surface, but not on the outer surface.



FIG. 5.—FROM FETUS OF FOUR MONTHS, SHOWING INTER-MAXILLARY SUTURE ON PALATAL SURFACE, WHERE THE INTER-MAXILLARY BONES HAVE UNITED WITH THE MAXILLARY BONES.

These inter-maxillary bones are designated by Huxley as *premaxillæ*, and in some animals they remain permanently as separate bones.

The buccal cavity comprises the mouth and nose until a lamina is formed from the superior maxillary tuberosity on either side, which has a horizontal inward direction. The two palatine lamellæ meet in the median line, in front, about the eighth week, and the septum is completed about the ninth week. The superior maxillary bones and the soft parts covering them unite at an early period with the inter-maxillary or incisive bone, and the median portion of the lower lip. The nostrils are formed by the olfactory fossæ opening into the upper or respiratory portion of the cavity.

THE SUPERIOR MAXILLARY BONES.

The *Superior Maxillary Bones*, two in number, are in pairs, and united on the median line of the face. They occupy the anterior upper part of the face, are of very irregular form, and consist of a body and processes. They are the largest bones of the face except the inferior maxilla, and enter into the formation of three cavities, the orbit, the mouth, and the nares; they also enter into the formation of the zygomatic and speno-maxillary fossæ, and the speno-maxillary and pterygo-maxillary fissures.

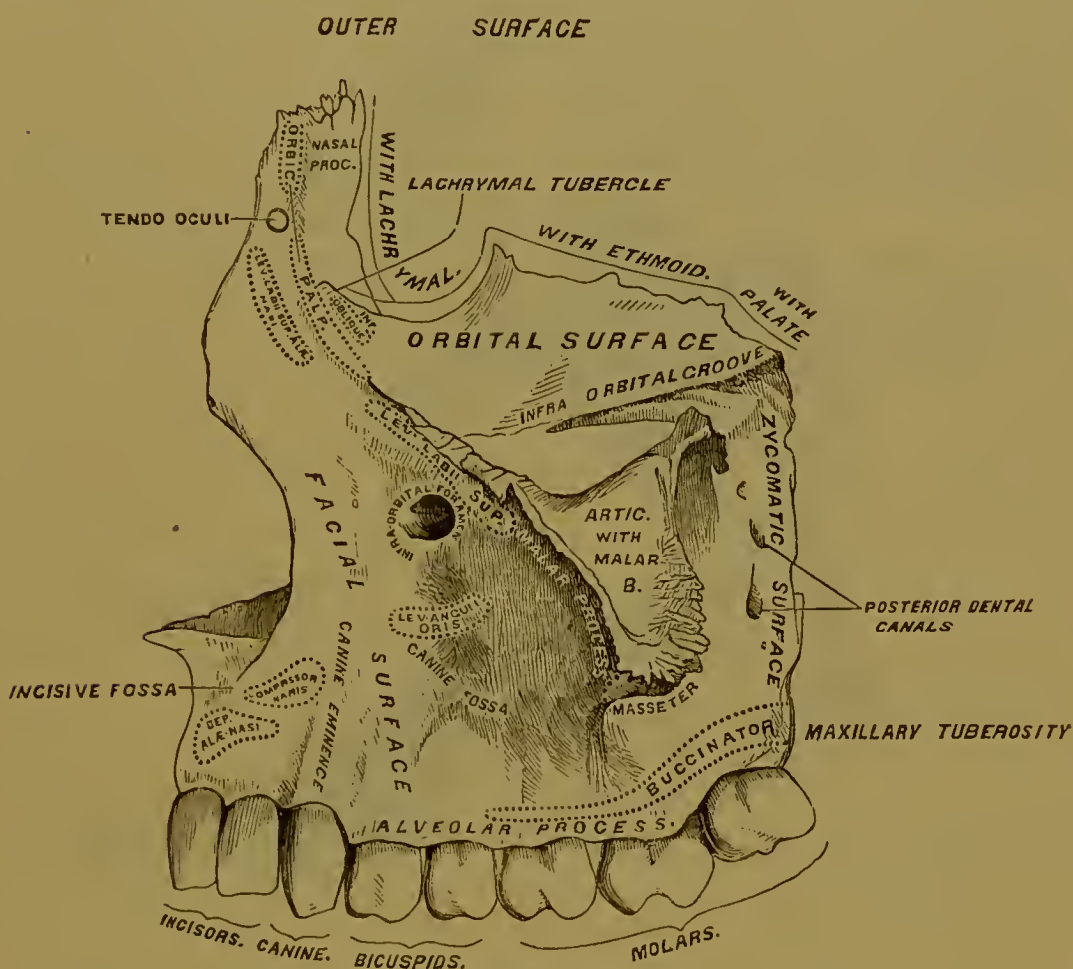


FIG. 6.

The body is the central part of the bone, and has four surfaces; namely, the external or facial, the posterior or zygomatic, the superior or orbital, and the internal or palatine.

The *External Surface* is irregularly convex, and has a depression about its center, just above the canine and first bicuspid teeth, called the canine fossa; immediately above which is the infra-orbital foramen for transmitting an artery and nerve of the same name; its upper and inner edge forms part of the lower margin of the orbit, to which is attached the levator labii superioris proprius muscle.

The *Posterior Surface* has a bulging, called tuberosity, which is connected with the palate bones, and bounds the antrum behind; it is perforated by three or four small holes—the posterior dental canals, which transmit nerves and blood-vessels to the molar teeth. This surface presents also on its nasal face a groove, which becomes, by articulation with the palate bone, the posterior palatine canal.

The *Internal Surface* extends from the alveolar processes in front to the horizontal plate of the palate bones behind, called the palatine processes, which are rough below, forming the roof of the mouth, and

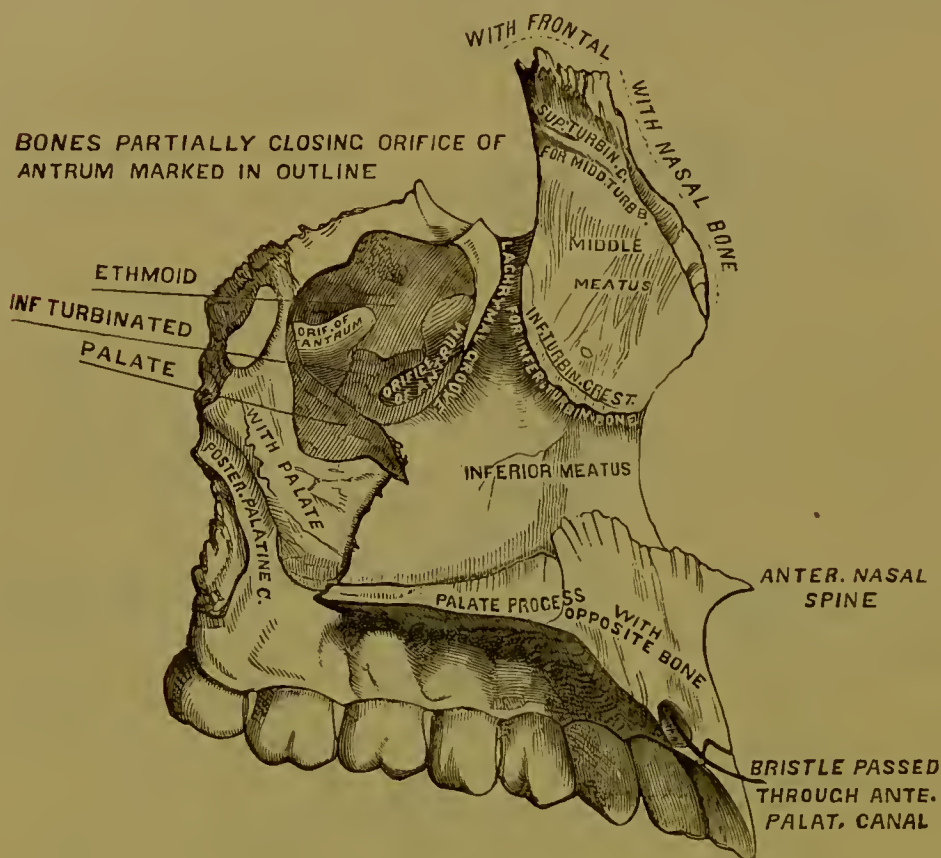


FIG. 7.

smooth above, making the floor of the nostrils. They are united along the median line, at the anterior part of which is the foramen incisivum, having two openings in the nares above, while there is but one in the mouth below. The body of the superior maxilla is occupied by a large and very important cavity called the *Antrum Highmorianum*, or Maxillary Sinus. This cavity is somewhat triangular in shape, with its base generally looking to the nose, and its apex to the malar process. Its upper wall is formed by the floor of the orbit, its lower by the alveoli of the molar teeth, which sometimes perforate this cavity. The canine fossa bounds it in front, while the tuberosity closes it

behind. But the shape of this cavity is exceedingly variable. In examining a collection of nearly one hundred maxillæ in the Dental Department of the University of Maryland, no two sinuses were found to be shaped alike ; and this difference is as marked between the right and the left in the same, as in different subjects. The floor of some is nearly flat, but in the majority of cases it is very uneven ; sometimes crossed by a single septum, varying from one-eighth to half an inch in height ; at other times there are found three or four septa, dividing the lower part of the cavity into as many separate compartments, with the bottom or floor of no two on a level with each other. Some are perforated by the roots of one or more teeth ; at other times the roots of several teeth extend considerably above the level of the floor of the antrum, covered by a lamina of bone scarcely thicker than bank-note paper. In other cases, the floor of the antrum is half an inch above the extremities of the roots of the teeth. This cavity also varies as much in size as it does in shape.

The opening of the antrum is, on its nasal portion or base, into the middle meatus of the nose ; in the skeleton it is large, while in the natural state it is much contracted by the ethmoid bone above, the inferior turbinated bone below, the palate bone behind, and by the mucous membrane which passes through the opening and lines the interior of the antrum. A deep groove lies in front of the opening in the antrum, which is converted into a canal for the nasal duct by the lachrymal and inferior turbinated bones.

The *Malar Process* is a rough, triangular process, marking the boundary between the external and internal surfaces. It presents on its upper margin a roughened surface for articulation with the malar bone.

The *Nasal Process* forms the lateral boundary of the nose. It is a thick, triangular prominence articulating at its upper extremity, by a serrated edge, with the frontal bone, and, by an uneven surface, with the ethmoid bone ; a little lower on its internal surface it offers a transverse ridge, the superior turbinated crest, for articulation with the middle turbinated bone ; below this is the inferior turbinated crest, to which is attached the inferior turbinated bone ; and lying between these crests is a smooth, concave space, forming part of the middle meatus, while beneath the inferior crest is a like space which forms part of the inferior meatus. By its anterior border it is articulated with the nasal bone, and by its posterior with the lachrymal bone, forming with it the canal for the nasal duct, while at the junction of the anterior lip of the nasal groove with the orbital surface is placed the lachrymal tubercle, serving as a guide to the duct in all operations for fistula lachrymalis.

The *Alveolar Process* is formed on the lower edge of the external surface; it is broader behind than in front, and is perforated with excavations corresponding in number with the teeth; those depressions which receive the teeth of more than one root are subdivided by bony septa into compartments of a sufficient number to receive these roots.

The bottom of each of these cavities is perforated by a small foramen, for the passage of nerves and blood-vessels which supply the teeth. The alveolar border externally presents a fluted appearance; the projections correspond with the alveolar cavities, and the depressions with the septa which divide them from one another.



FIG. 8.

The *Palate Process* forms the roof of the mouth and part of

the floor of the nose; it is thick and strong, and presents in front the orifice of the anterior palatine canal through which passes the anterior palatine vessels, whilst the inferior naso-palatine nerves pass along the inter-maxillary suture. The inferior surface at the back part has a deep groove, sometimes a canal, for the passage of the posterior palatine vessels, and a nerve of large size; it is also perforated with numerous foramina for the passage of nutrient vessels. The outer border is closely attached to the rest of the bone. The inner border, thicker in front than behind, presents a ridge, which, together with a similar ridge on the opposite bone, forms a groove in which the vomer is received. The anterior margin is prolonged into a sharp process, the nasal spine. By its posterior border it articulates with the horizontal plate of the palate bone.

The structure of the upper jaw, with its alveolar and numerous other processes, is thick and cellular; the cancellated structure being invested with a thin layer of compact bone.

It is articulated with two bones of the cranium, the frontal and ethmoid, and seven of the face, namely: the nasal, malar, lachrymal, palate, inferior turbinated, vomer, and to its fellow, by sutures; also to the teeth by the articulation termed *gomphosis*.

Its development commences at so early a period of intra-uterine life, and ossification proceeds so rapidly, that the number of ossific centers is uncertain; some give a center for the body and each process, others think that most probably there are but four centers in all. It may be seen as early as the thirty-fifth or fortieth day after concep-

tion; and although at birth it has acquired but little height, it has increased considerably in breadth. But at this period the alveolar border, which constitutes the largest portion of the bone, is almost in contact with the orbit. The antrum is still scarcely perceptible, but as the vertical dimensions of the bone are increased, it is gradually developed. With the loss of the teeth, the alveolar border nearly disappears, so that the vault of the palate loses its arched form, and sometimes becomes almost flat.

The *Upper or Orbital Surface* is triangular in shape, with its base in front forming the anterior, lower, and internal edges of the orbit, while its apex extends back to the bottom, forming the floor of the orbit and roof of the antrum; its internal edge is united to the lachrymal, ethmoid, and palate bones; its external edge assists in forming the spheno-maxillary fissure, and along its central surface is seen a canal running from behind, forward and inward—the infra-orbital canal. This canal divides into two; the smaller is the *anterior dental*, which descends to the anterior alveoli along the front wall of the antrum; the other is the proper continuation of the canal, and ends at the infra-orbital foramen.

THE INFERIOR MAXILLARY BONE.

The *Inferior Maxillary Bone* (Fig. 9) is the largest bone of the face,

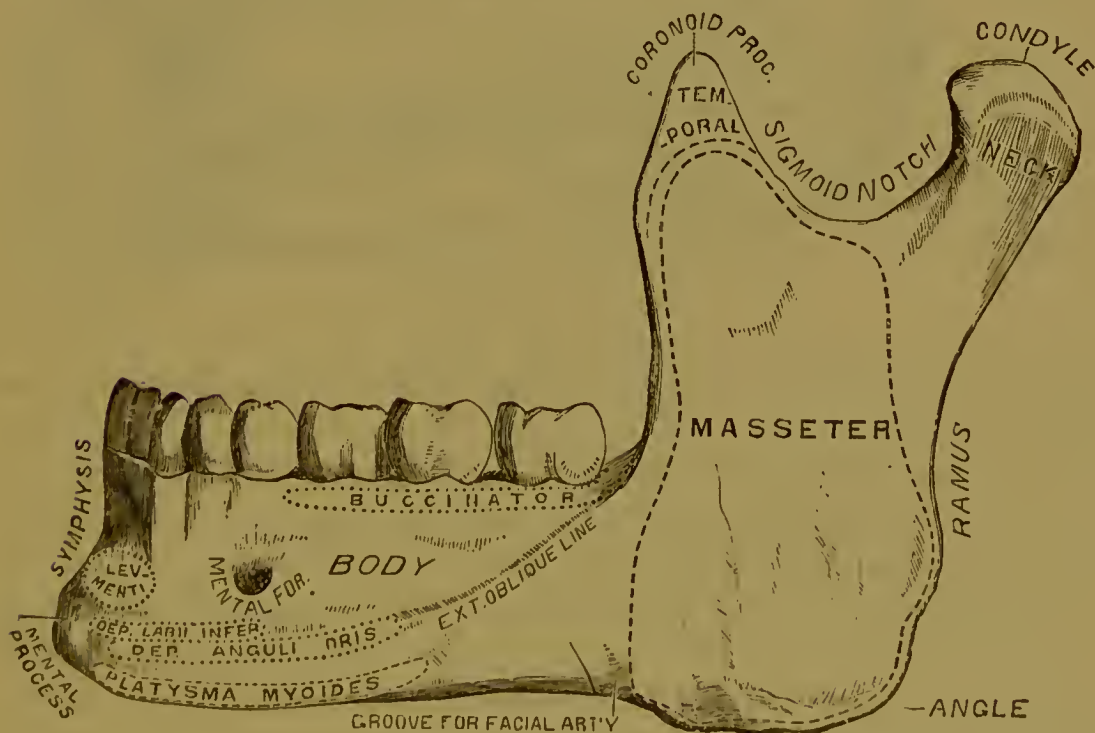


FIG. 9.

and though single in the adult, it consists of two symmetrical pieces in the fetus, which become joined at the symphysis in the first year.

It occupies the lower part of the face, has a parabolic form, and extends backward to the base of the skull.

It is divided into a body and extremities.

The body is the middle and horizontal portion ; this is divided along its center by a ridge called the *symphysis*, which is the place of separation in the infant state ; the middle portion projects at its inferior part into an eminence called the *mental process*, or chin ; on each side of which is a depression for the muscles of the lower lip ; and externally to these depressions are two foramina, called *anterior mental*, for transmitting an artery and nerve of the same name.

The horizontal portions extend backward and outward, and on

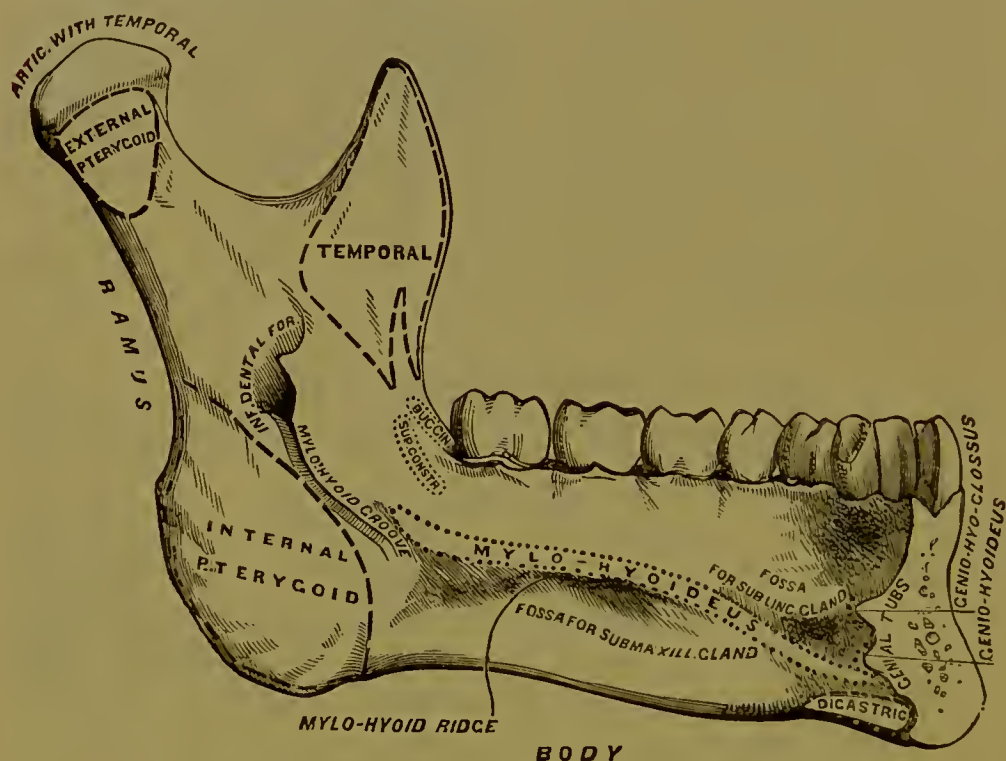


FIG. 10.

the outward surface have an oblique line for the attachment of muscles.

On the inner surface of the middle part, behind the chin, along the line of the symphysis, there is a chain of eminences called *genial tubercles*, to the superior of which the frenum linguæ is attached, to the middle the genio-hyo-glossi, and to the inferior the genio-hyoid muscles ; on each side of these eminences are depressions for the sublingual glands ; and beyond these depressions there runs an oblique ridge upward and outward, to the anterior part of which is attached the mylo-hyoid muscle, and to the posterior part, the superior constrictor of the pharynx ; this latter muscle is consequently involved more or less in the extraction of the last molar tooth. Below this line

there is a groove for the mylo-hyoid nerve, and a depression, the sub-maxillary fossa, for the reception of the submaxillary gland.

The alveolar border, in the fetus, constitutes nearly the whole body of the bone. After the loss of the teeth, this part of the inferior maxillary is gradually wasted. The alveolar border in the lower jaw describes a rather smaller arch than it does in the upper, and both its anterior walls are thinner than the posterior. Passing over the inferior border, near the junction of the body with the ramus, is a groove for the facial artery.

The extremities of the body have two large processes rising up to an obtuse angle, named the *rami* of the lower jaw. These processes are flat and broad on their surfaces; the outer one is covered by the masseter muscle; the inner one has a deep groove which leads to a large hole, the *posterior dental* or maxillary foramen, for transmitting the inferior dental nerves and vessels to the dental canal running along the roots of the teeth. This foramen is protected by a spine to which the speno-maxillary ligament is attached.

The ramus has a projection at its lower part, which is the angle of the lower jaw; its upper ridge is curved, having a process at each end—the anterior one is the *coronoid process*; this is triangular, and has the temporal muscle inserted into it; the posterior is the *condyloid*, and articulates with the temporal bone. This process has a neck which receives the insertion of the external pterygoid muscle.

The *Coronoid Process* is thin, flat, and triangular. To its external surface is attached the temporal and masseter muscles. On its internal surface is a long latitudinal ridge extending to the posterior part of the alveolar process, and to which is attached the temporal muscle above and the buccinator muscle below. In front of this ridge is a deep groove, to which the temporal and buccinator muscles are in part attached.

The *Condyloid Process* consists of two portions—a condyle and a neck. The condyle is of an oval form, convex both laterally and from before backward. The neck of the condyle, flattened from before backward, convex on its posterior surface, presents anteriorly a depression, the pterygoid fossa, for the attachment of the external pterygoid muscle. Between these two processes is the sigmoid notch, a semilunar depression over which passes the masseteric artery and nerve.

The structure of the inferior maxilla is compact externally, cellular within, and is traversed the greater part of its extent by the inferior dental canal.

The lower jaw is developed from two centers of ossification, which meet at the symphysis. It articulates on each side, by one of its con-

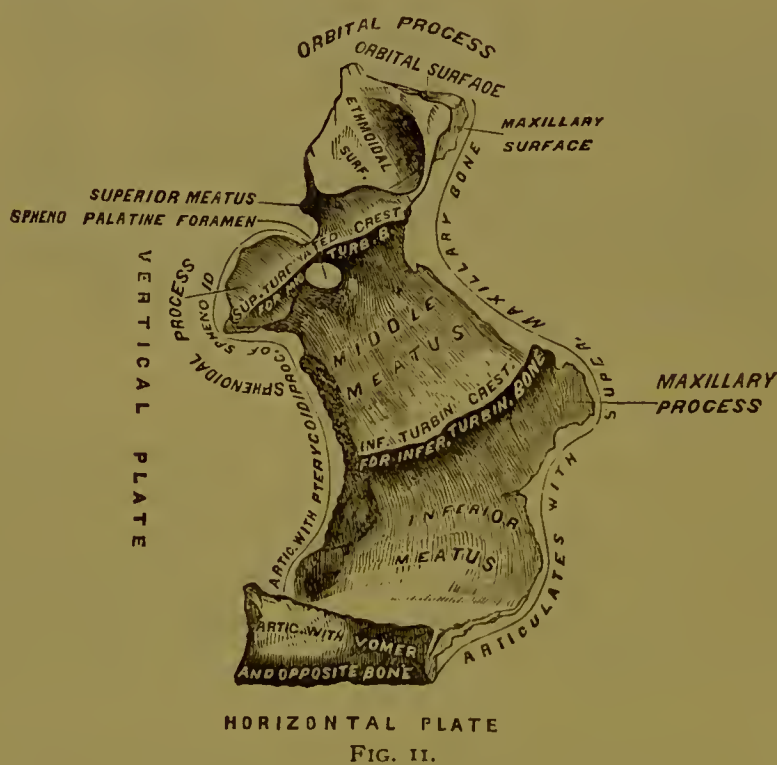
dyles, with the glenoid cavity of the temporal bone, situated at the base of the zygomatic process. This cavity is divided into two portions—an anterior and a posterior. The former constitutes the articular portion, the latter lodges a process of the parotid gland. The two are separated by the fissure of Glaserius, which transmits the chorda tympani nerve, the laxator tympani muscle, and the anterior tympanic artery. It also gives lodgment to the long process, *processus gracilis*, of the malleus.

Between this cavity and the condyle there is interposed an inter-articular cartilage, so molded as to fit the two articular surfaces. The circumference of this being free, except where it adheres to the external lateral ligament, affords attachment to a few fibres of the external pterygoid muscle, and facilitates the movements of the joint.

The union of this articulation is maintained by the external lateral, the speno-maxillary, and the stylo-maxillary ligaments.

THE PALATE BONES.

The *Palate Bones*, two in number, are situated at the back part of the superior maxillary bone, between its tuberosities and the pterygoid process of the sphenoid bone.



The palate bone is divided into two plates: the inferior, or horizontal, and the superior, or vertical.

The *horizontal plate* is broad and on the same line with the palate

processes of the superior maxillary bone; its upper surface is smooth and forms the posterior floor of the nostrils; the lower surface is rough and forms the posterior part of the roof of the mouth; its anterior edge is connected with the palate processes of the upper jaw, and its posterior is thin and crescentic, to which is attached the *velum-pendulum palati*, or soft palate; at the posterior point of the suture, uniting the two palate bones, there projects backward a process called the *posterior nasal spine*, which gives origin to the *azygos-uvulæ* muscle. The *vertical plate* ascends, helps to bound the nasal cavity, diminishes the opening into the antrum by projecting forward, and by its external posterior part, in conjunction with the pterygoid processes of the sphenoid bone, forms the *posterior palatine canal*; the lower orifice of which is seen on the margin of the palate plate, and is called the *posterior palatine foramen*, transmitting the palatine nerve and artery to the soft palate; behind this foramen is often seen a smaller one, passing through the base of the pterygoid process of this bone, and sending a filament of the same nerve to the palate.

The upper end of the vertical or nasal plate has two processes—the one is seen at the back of the orbit, called the *orbital process*; the other is posterior, and fits against the under surface of the body of the sphenoid bone. Between these two processes is a foramen, the *spheno-palatine*, which transmits to the nose a nerve and artery of the same name.

The palate bone articulates with six others, namely: the superior maxillary, inferior turbinated, vomer, sphenoid, ethmoid, and opposite palate.

The structure of this bone is very thin, and consists almost entirely of compact tissue. Its development, it is said, takes place by a single point of ossification at the union of the vertical, horizontal, and pyramidal portions.

THE FRONTAL BONE.

The Frontal Bone consists of two portions—a vertical, or frontal, at the front part of the cranium, forming the forehead, and a horizontal,

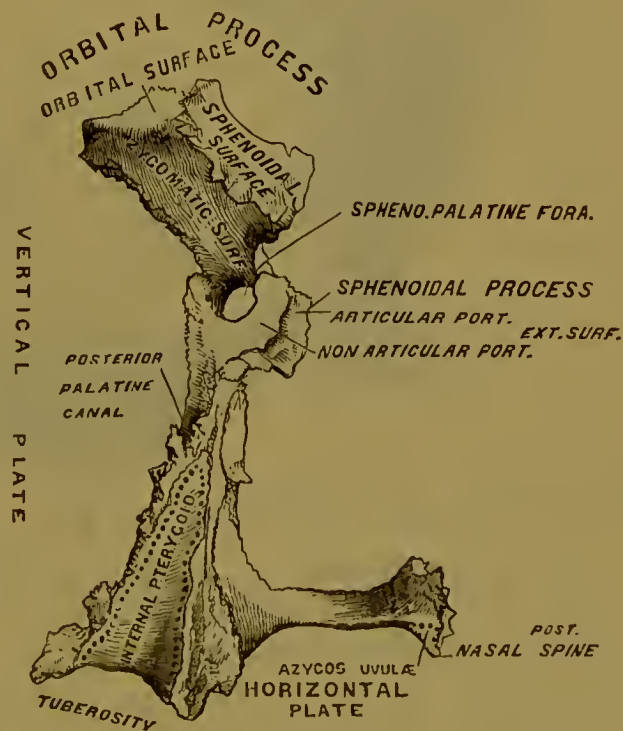


FIG. 12.

or orbito-nasal, which enters into the formation of the roofs of the orbits of the eyes and nasal fossæ. The following points are found on the vertical portion:—

The *frontal eminences*, one on each side of the median line; the *superciliary ridges*, behind which are the *frontal sinuses*; the *supra-orbital notches*, or *foramina*, situated in the supraorbital arches about their inner third, for the supraorbital vessels and nerves; the *nasal eminence* at the lower end of the frontal depression; the *external angular processes*, which articulate with the malar bones and form the anterior part of the temporal ridges; the *internal angular processes*,

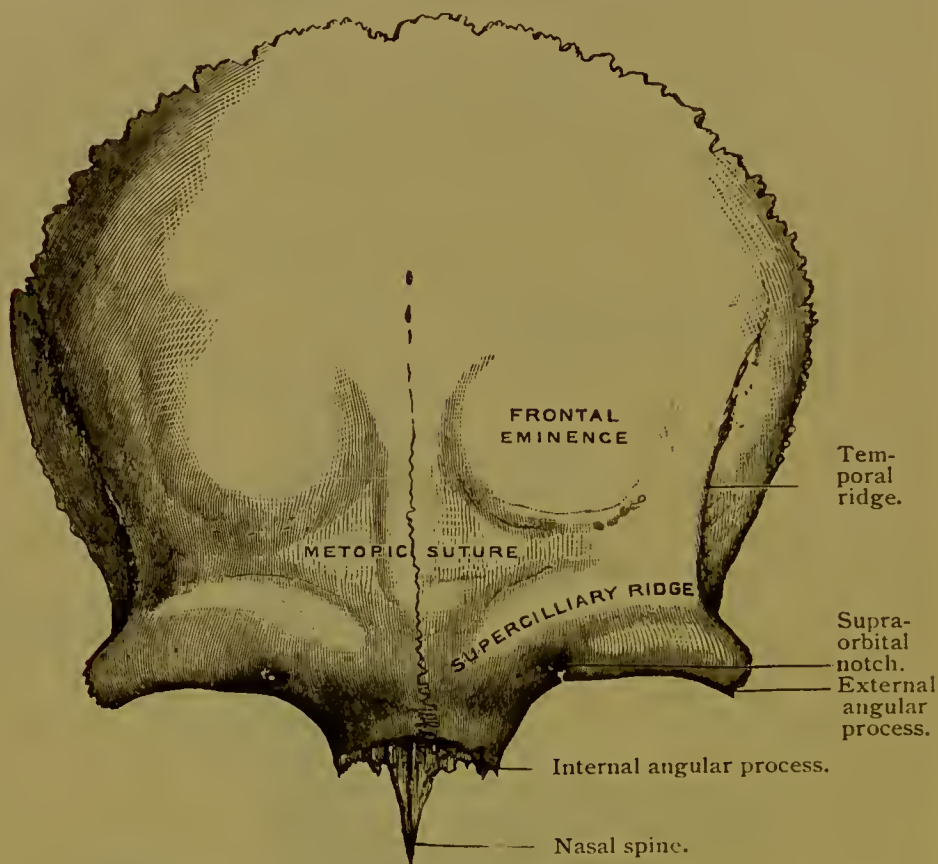


FIG. 13.—THE FRONTAL. (*Anterior view.*)

which articulate with the lachrymal bones; the *nasal spine and notch*, between the internal angular processes; and, internally, a *groove* for the superior longitudinal sinus and the *falx cerebri*; and the *frontal crest*, for the attachment of the *falx cerebri*; and the *foramen cæcum*, for a small vein to the longitudinal sinus; and depressions and elevations, for the convolutions of the brain. Between the two tables of the vertical portion are the *frontal sinuses*, which are lined with mucous membrane and open into the middle meatus of the nose by means of an *infundibulum* for each one.

The following points are found on its horizontal portion: a *fossa*

for the lachrymal gland, near the external angular process; a depression at the nasal margin, for the pulley of the superior oblique muscle; the *ethmoidal notch*, having on its margin the *anterior ethmoidal foramen*; the *posterior ethmoidal foramen*, the former for the anterior ethmoidal vessels and the nasal branch of the ophthalmic nerve, and the latter for the posterior ethmoidal vessels; also *grooves* on the cranial surface, for branches of the anterior and middle meningeal arteries.

The frontal bone articulates with twelve bones: the sphenoid, ethmoid, two parietal, two nasal, two superior maxillary, two lachrymal, and two malar. The following muscles are attached to it: temporal, corrugator supercillii, and orbicularis palpebrarum.

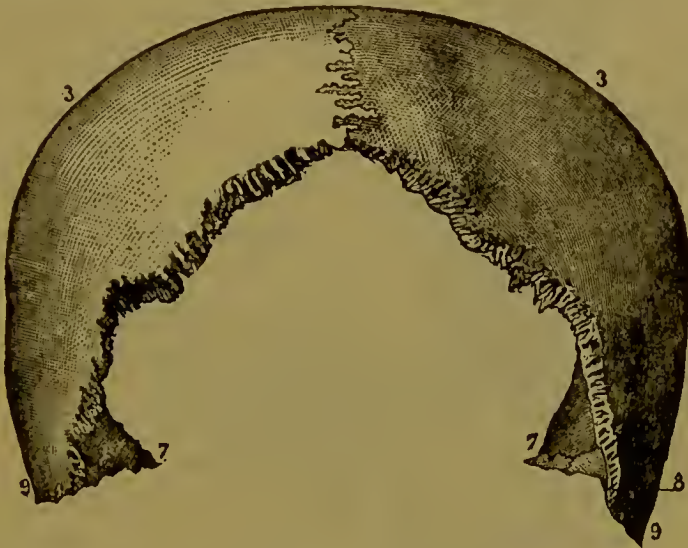


FIG. 14.

3, 3. Parietal bones. 7, 7. Spheno-parietal sutures. 9, 9. Temporo-parietal sutures.

THE PARIETAL BONES.

The two Parietal Bones are quadrilaterally shaped, so named from their forming the lateral walls of the skull, and situated at the superior and lateral regions of the cranium. They are joined at the superior borders by the *sagittal suture*, and the anterior border joins the frontal bone by a part of the *coronal suture*; the posterior border articulates with the occipital bone, forming the *lambdoidal suture*; the inferior border articulates with the sphenoid and temporal bones. Externally this bone is convex, and on this surface are found the following points: the *temporal ridge*, which is continuous with the same ridge on the frontal bone; the *parietal eminence*, the point where ossification commences; the *parietal foramen*, which is close to the upper border and transmits a vein to the superior longitudinal sinus. Internally this bone is concave, and on this surface the following points are found: *depressions*, for the Pacchionian bodies and for the cerebral convo-

lutions of the brain; *furrows*, for branches of the middle meningeal artery; a groove, for the lateral sinus, at the posterior inferior angle; a *half-groove* along the upper border, for the superior longitudinal sinus of the dura mater. Each parietal bone articulates with five bones, namely, the frontal, occipital, sphenoid, temporal, and the opposite parietal bone. The temporal muscle is the only one attached to the parietal bone.

THE OCCIPITAL BONE.

The Occipital Bone is trapezoidal in form, curved upon itself, and situated at the posterior and inferior region of the cranium. Its exter-

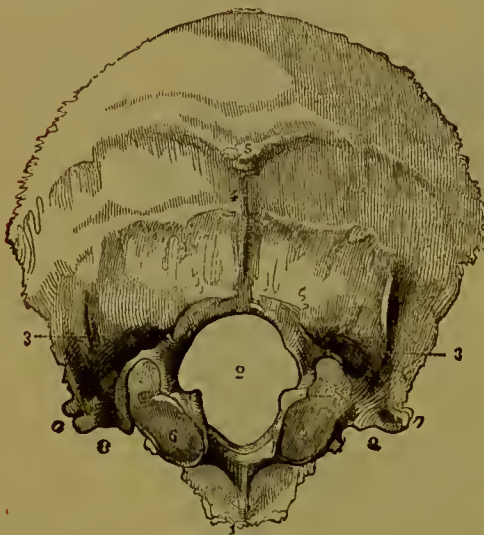


FIG. 15.—OCCIPITAL BONE. (*Postero-inferior view.*)

1. Basilar process. 2. Foramen magnum.
- 3, 3. Posterior condyloid foramina. 4. Crest.
5. External occipital protuberance. 6, 6. Condyles. 7, 7. Jugular processes. 8, 8. Jugular fossæ.

nal surface is convex, and upon it are found the following points:

The *external oblique protuberance and crest*, which affords attachment for the ligamentum nuchæ; the *superior and inferior curved lines*, which extend outward on each side of the external occipital crest; the *foramen magnum*, which transmits the medulla oblongata, the vertebral arteries, and the spinal accessory nerves; the *two condyles*, for articulation with the atlas vertebra; *two tubercles*, one on each condyle, for the check ligaments; the *two anterior condyloid foramina*, for the hypoglossal nerves; the *two posterior condyloid foramina*, when present, for veins; *two jugular processes*,

which assist in forming the foramen lacerum posterius basis cranii. Its internal surface is concave, and presents the following points: *four fossæ*, for the cerebellar and posterior cerebral lobes; the *internal occipital protuberance*, where the six cranial sinuses meet to form the torcular Herophili; the *crucial ridge*, which is the vertical portion for the falx cerebri and falx cerebelli; a *groove*, for the lateral sinus and the inferior petrosal sinus; the *basilar process*, which lies in front of the foramen magnum and articulates with the body of the sphenoid bone, and grooved internally for the medulla oblongata and pons varolii, which lie upon it; inferiorly it is rough, for the attachment of the muscles, and presents the *pharyngeal spine* for the attachment of the superior constrictor muscle of the pharynx. The occipital bone articulates with six bones,—the two parietal, the two temporal, sphenoid, and

atlas. The muscles attached to the occipital bone are twelve in number,—the occipito-frontalis, trapezius, sterno-cleido-mastoid, complexus, splenius, obliquus capitis superior, rectus capitis posticus major and minor, superior constrictor of pharynx, rectus capitis anticus major and minor, and the rectus capitis lateralis.

THE TEMPORAL BONES.

The two Temporal Bones are situated at the inferior lateral portion of the skull, and contain the organs of hearing. Each bone is divided into three parts,—the *squamous* (scale-like), *mastoid* (nipple-like), and *petrous* (hard), and the bone is named from *tempus*—time.

“The squamous portion is semicircular, smooth externally, and grooved internally, for the middle meningeal artery, with depressions

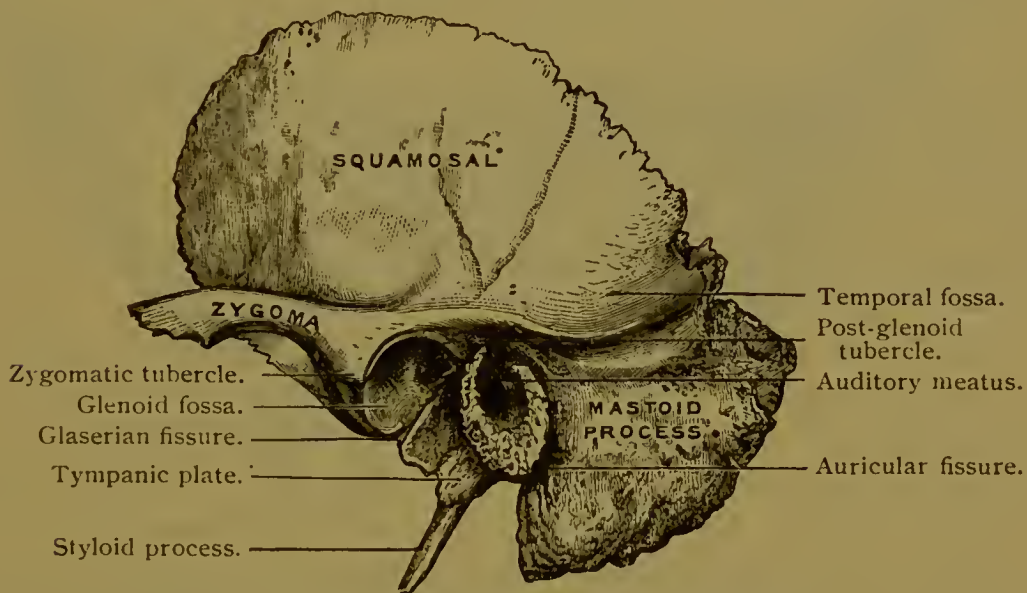


FIG. 16.—THE LEFT TEMPORAL BONE. (Outer view.)

for the cerebral convolutions. Externally the following points are found: the *zygomatic process*, or *zygoma*, extending forward to articulate with the malar bone; the *zygomatic tubercle* at the base of the process for the external lateral ligament of the lower jaw; the *eminencia articularis*, which is formed by the anterior root of the zygomatic process; the *glenoid fossa*, which is between the anterior and middle roots of the zygomatic process, its anterior part receiving the condyle of the lower jaw, and its posterior part lodging the parotid gland; the *Glaserian fissure*, which divides the glenoid fossa and transmits the laxator tympani muscle, the tympanic artery, and the processus gracilis of the malleus; the *opening of the canal of Huguier*, which lies in the angle between the squamous and petrous portions, and transmits the chorda tympani nerve; and a part of the *temporal ridge*. The mastoid portion presents the following points:

it projects like a nipple from the inferior part of the bone posteriorly, and internally it is grooved for the lateral sinus. Externally are found the *mastoid foramen* for a vein; the *mastoid process* at the tip, for sterno-cleido-mastoid, splenius, and trachelo-mastoid muscles; the *digastric fossa*, for the posterior belly of the digastric muscle; the *occipital groove*, for the occipital artery; and the mastoid cells, which open on the posterior wall of the middle ear and are lined with mucous membrane.

The petrous portion is hard, pyramidal in form, and contains the internal and middle ear, projecting inward and forward, and having a base, an apex, three surfaces, and three borders. On the base are found the *meatus auditorius externus*—the external opening of the ear; and the *auditory process*, which is an osseous ring for the external cartilage of the ear. The Apex is situated internally at the base of the skull, and forms the outer boundary of the foramen lacerum medium, and contains the internal carotid canal. The Anterior Surface, from within outwards, presents the *opening of the carotid canal*, for the internal carotid artery and plexus. The *depression* contains the Gasserian ganglion of the fifth pair of nerves. The *hiatus fallopii* is for the great petrosal nerve and an artery; and the *foramen* is for the small petrosal nerve.

The Posterior Surface presents the *meatus auditorius internus*, for the transmission of the seventh and eighth pairs of cranial nerves and the auditory artery, and also lodges a process of the dura mater. The Inferior Surface presents the *opening of the carotid canal* for transmitting the internal carotid artery, and the carotid plexus of the sympathetic nerve; the *rough quadrilateral surface*, for the origin of the tensor tympani and levator palati muscles; the *aqueductus cochlea*, for transmitting a vein from the cochlea; the *jugular fossa*, a depression for the sinus of the internal jugular vein, forming with the occipital bone the foramen lacerum posterius, which transmits that vein and the eighth pair of nerves; a *foramen* for Jacobson's nerve and another foramen for Arnold's nerve; the *jugular surface*, for articulation with the jugular process of the occipital bone; the vaginal process ensheathing the root of the styloid process; the *styloid process*, for the stylo-pharyngeus, stylo-hyoid, and the stylo-glossus muscles; the *stylo-mastoid foramen*, for the exit of the facial nerve, and the entrance of the stylo-mastoid artery; the *septum tubæ lamina*, which separates the tympanum and is called *processus cochleariformis*; *opening* of the canal for the tensor tympani muscle; the *osseous opening* of the Eustachian tube. The temporal bone articulates with five bones,—the occipital, parietal, sphenoid, malar, and inferior maxillary. Fourteen muscles are attached to the different parts of this bone: the tem-

poral, masseter, occipito-frontalis, sterno-cleido-mastoid, splenius capitis, trachelo-mastoid, digastric, retrahens aurem, tensor tympani, levator palati, stapedius, stylo-glossus, stylo-hyoid, and stylo-pharyngeus.

THE SPHENOID BONE.

The sphenoid bone resembles a bat with outstretched wings, and is named from the Greek word *σφεν*, a wedge. Wedged in between the bones of the skull anteriorly, this bone enters into the formation of five cavities, four fossæ, three fissures, and consists of *a body, two greater wings, two lesser wings, two pterygoid processes, two styloid processes, six clinoid processes, three lesser processes, twelve foramina*, has twelve articulations with other bones of the head and face, and to it

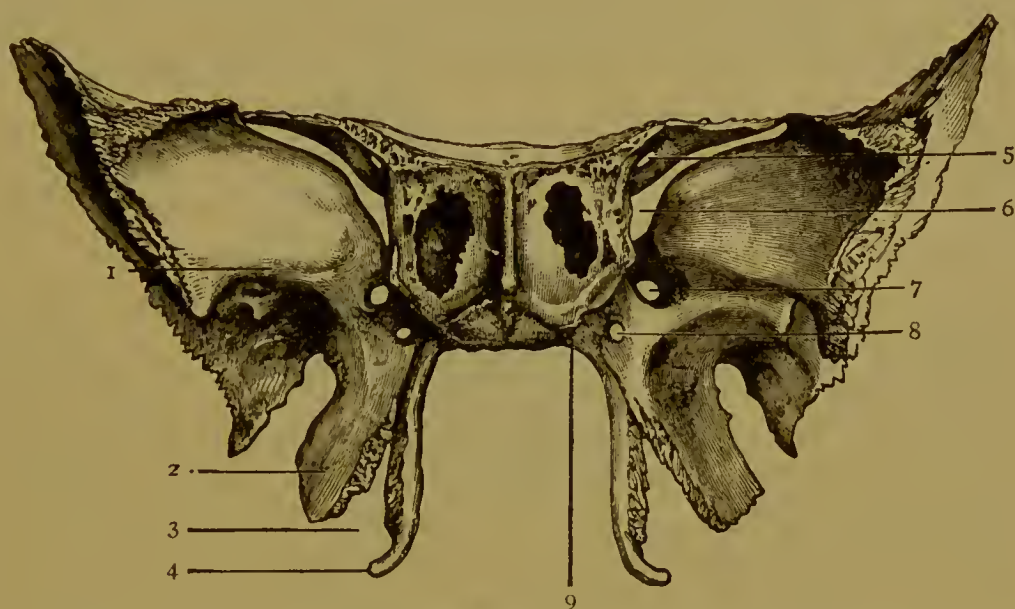


FIG. 17.—THE SPHENOID. (*Anterior view.*)

1. Orbital surface. (The pointer crosses the malar crest.) 2. Ext. pterygoid plate. 3. Pterygoid notch. 4. Hamular process. 5. Optic foramen. 6. Sphenoidal fissure. 7. Foramen rotundum. 8. Vidian canal. 9. Pterygo-palatine canal.

are connected twelve pairs of muscles ; it has also ten points of ossification. The body of the sphenoid bone is cuboid in shape, and located in the median line. Its Upper Surface from before backward, presents the following points : A *smooth surface*, grooved for the olfactory nerves ; *ethmoidal spine* ; *optic groove*, for the support of the commissure of the optic nerve ; *olivary process*, in the form of an olive-shaped eminence behind the optic groove ; *middle clinoid processes*, bounding the sella turcica in front ; *sella turcica*, which lodges the pituitary body and circular sinus of the brain (so called from its resemblance to a Turkish saddle) ; *dorsum sellæ* (or back of saddle), which is grooved for the sixth pair of nerves ; *posterior clinoid processes*, for attachment of the tentorium cerebelli ; *lateral grooves*, for the cavernous sinus and internal carotid artery.

The Anterior Surface is almost vertical, and presents the following points: *lamella* in the median line, articulating with the perpendicular plate of the ethmoid bone, and forming part of the nasal septum; *opening of the sphenoidal sinuses* or cavities in the body of the bone—common to adults only; *sphenoidal turbinated bones* (the pyramids of Wistar), which partially close the sinuses, and articulate with the ethmoid and palate bones.

The Inferior Surface assists in forming the nasal fossæ, and presents the following points: *rostrum*, which articulates with a groove on the vomer; *vaginal processes*, one on each side of the rostrum; *pterygo-palatine grooves*, which in connection with the sphenoidal processes of the palate bones form the pterygo-palatine canals for the transmission of the pterygo-palatine arteries and nerves. Each of the greater wings of the sphenoid bone on its superior surface presents the following points: *foramen rotundum*, for the superior maxillary division of the fifth pair of nerves; *foramen ovale*, for the inferior maxillary division of the fifth pair of nerves, the small petrosal nerve, and the small meningeal artery; the *foramen vesalii*, for transmitting a small vein; *foramen spinosum*, for transmitting the middle meningeal artery.

The Anterior Surface assists in forming the external wall of the orbit of the eye, the speno-maxillary and sphenoidal fissures. It articulates with the frontal and malar bones, and contains a *notch*, for a branch of the ophthalmic artery; *aspine*, for part of the lower head of the external rectus muscle; the *external orbital foramina*, for arterial branches.

The *external surface* presents the following points: *pterygoid ridge*, which divides the temporal fossa from the zygomatic; the *spine of the sphenoid*, to which the internal lateral ligament of the lower jaw and the laxator tympani muscles are attached. The circumference is partly serrated for articulation with the temporal bone, and partly smooth for the anterior margin of the foramen lacerum medium and the inferior margin of the sphenoidal fissure, which margin it assists in forming.

The lesser wings of the sphenoid bone (Processes of Ingrassias) terminate internally in the anterior clinoid processes. Their anterior borders articulate with the orbital plate of the frontal bone, while the posterior are free, dividing the anterior cerebral fossa from the middle. Intimately connected with each of these wings are the *optic foramen*, for the transmission of the optic nerve and the ophthalmic artery; also the *sphenoidal fissure*, or foramen lacerum anterius, which transmit the third, fourth, the ophthalmic division of the fifth and sixth pairs of nerves, the ophthalmic vein, branches of the lachrymal and middle meningeal arteries, some filaments of the sympathetic nerve, and a process of the dura mater. The wing-like processes (*pterygoid pro-*

cesses) descend, one on each side of the body of the bone, and each divide into two thin bony plates connected together in front, and presenting the pterygoid fossa, the origin of the external pterygoid muscle; the *scaphoid fossa*, which serves as the origin of the tensor palati muscle; the *vidian canal* at the root of the process for the vidian nerve and vessel; the *triangular notch* at the end of the process, which articulates with the pterygoid process of the palate bone.

The sphenoid bone articulates twelve other bones of the cranium and face, such as the remaining seven of the cranium and the five of the face, viz.: the vomer, two malar, and two palate bones. The muscles attached to the sphenoid bone are twelve pairs, viz.: the six orbital muscles, the temporal, external and internal pterygoids, superior constrictor, tensor palati, and laxator tympani.



FIG. 18.—THE ETHMOID. (*Side view.*)

THE ETHMOID BONE.

The Ethmoid Bone is light and spongy, depending from the ethmoidal notch of the frontal bone, and from between its orbital plates. It consists of a body and two lateral masses, and is named from the Greek word *ἠθμός*, a sieve. The body of this bone consists of a horizontal cribriform plate, and a perpendicular plate, and presents the following points: the *crista galli*, or cock's comb, projecting upwards for the attachment of the anterior end of the falx cerebri; the *cribriform plate* on each side of the crista galli, which is concave for the olfactory bulbs, and perforated for the transmission of the olfactory nerves, the nasal branch of the ophthalmic nerve, and numerous small vessels; the *perpendicular plate*, which assists to form the septum of the nose, usually inclined to one side, and grooved for filaments of the olfactory

nerves, and having attached to it the cartilage of the nose. The *lateral masses* consist of a number of cellular cavities and each mass presents the following points: *ethmoid cells*, the anterior opening by the infundibulum into the middle meatus of the nose, the posterior opening into the superior meatus of the nose; the *os planum*, or orbital plate, which helps to form the inner wall of the orbit of the eye, and which is notched superiorly to form with the frontal bone the two ethmoidal foramina; the *uneiform process*, which descends to articulate with the inferior turbinated bone, and forms part of the inner wall of the antrum; the *superior turbinated process*, which curves downward and outward; the *middle turbinated process*, which is larger and more curved than the superior. These processes bound the superior meatus of the nose and are frequently called the *superior* and *middle turbinated bones*. The ethmoid bone articulates with fifteen bones—all those of the face, except the malar, and the frontal and sphenoid of the cranium. There are no muscles attached to it.



FIG. 19.—NASAL BONES.
(External aspect.)

- 1, 1. The two nasal bones. 2, 2. Superior extremity. 3, 3. Inferior border. 4, 4. Internal border. 5, 5. External border.

THE NASAL BONES.

The Nasal Bones are two in number, and together they form the bridge of the nose by articulation with each other in the median line. They are convex externally, and concave internally, and are grooved for the external branch of the nasal nerve and for small arteries. Each of the nasal bones articulates with four bones—the frontal, ethmoid, superior maxillary, and the opposite nasal bone. They have no muscles attached to them.

THE MALAR BONES.

The Malar or Cheek Bones are situated at the outer and upper part of the face, and assist in forming the cavities of the orbits of the eyes, and the temporal and zygomatic fossæ. Each malar bone presents the following points: An *external surface*, which is convex, for the attachment of the zygomatic muscles; a *foramen*, externally, for the malar branch of the temporo-malar nerve; a *foramen*, internally, for the temporal branch of the temporo-malar nerve; a *frontal process* which articulates with the external angular process of the frontal bone; an *orbital process* projecting backwards, and forming part of the floor and outer wall of the orbit of the eye, and also a part of the temporal fossa; a *zygomatic process*, which projects backwards to articulate with the zygomatic process of the temporal bone by a serrated edge; an *upper border*, which forms the outer and inferior

margin of the orbit of the eye; a *lower border*, which is thick and rough for the origin of the masseter muscle; an *anterior border*, which articulates with the superior maxillary bone; a *posterior border*, which terminates the temporal fossa below.

Each Malar Bone articulates with four bones: the frontal, sphenoid, temporal, and superior maxillary. Five muscles are attached to it: the levator labii superioris, zygomaticus major and minor, masseter and temporal.



FIG. 20.—MALAR BONE. (*External aspect.*)

1. Orifice for malar nerve. 2, 2. Superior or orbital border. 3, 3. Inferior or zygomatic border. 4, 4. Posterior or temporal border. 5, 5. Anterior or maxillary border. 6. Superior angle. 7. Inferior angle. 8. Anterior angle. 9. Posterior angle.

THE LACHRYMAL BONES.

The Lachrymal Bones consist of two small quadrilateral bones, situated in the anterior part of the inner wall of the orbit of the



FIG. 21.—LACHRYMAL BONE. (*External aspect.*)

- 1, 1. Vertical crest, dividing external surface into two parts. 2. Spine, in which crest terminates. 3. Sulcus contributing to formation of lachrymal canal. 4. Continuation of preceding, contributing to formation of nasal canal. 5. Posterior division of external surface, contributing to formation of orbit. 6, 6. Anterior border. 7, 7. Posterior border. 8. Superior extremity. 9. Portion of inferior border that articulates with lachrymal process of inferior turbinate bone. 10. Portion that articulates with orbital plate of superior maxillary bone.

eye. Each lachrymal bone presents the following points: a *groove* on the external surface, which forms a part of the nasal duct; a *ridge*, externally, for attachment of the tensor tarsi muscle; a *furrow*, internally, corresponding to the ridge on the external surface; the *hamular process*, which projects downwards to articulate with the lachrymal process of the inferior turbinate bone; an *internal surface*, which closes the anterior ethmoidal cells. Each lachrymal bone articulates with four bones: the frontal, ethmoid, superior maxillary, and inferior turbinate. There is but one muscle attached to it—the tensor tarsi.

THE INFERIOR TURBINATED BONES.

The Inferior Turbinate Bones are two in number, situated in the nasal fossæ, their convex surfaces presenting inwardly. They are in the form of two thin, curved osseous plates, and each is attached above to the inferior turbinate crests of the superior maxillary and palate bones, and presents the following: The *lachrymal process*, which



assists in forming the nasal duct, by articulation with the lachrymal and superior maxillary bones ; the *ethmoidal process*, which articulates

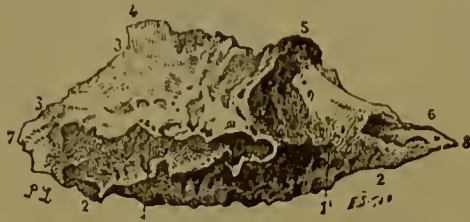


FIG. 22.—INFERIOR TURBINATED BONE.
(Internal or Convex aspect.)

- 1, 1. Antero-posterior ridge, dividing the internal surface into two almost equal parts.
- 2, 2. Inferior border.
- 3, 3. Anterior portion of superior border, articulating with nasal process of superior maxillary bone.
4. Lachrymal process.
5. Ethmoidal process.
6. Portion of superior border that articulates with palate bone.
7. Anterior extremity.
8. Posterior extremity.

with the unciform process of the ethmoid bone, thus assisting to partially close the aperture of the antrum ; the *maxillary process*, which also assists in partially closing the aperture of the antrum by bending over the lower edge of that orifice ; the *free border*, below, which reaches to about one-half an inch above the floor of the nose. Each inferior turbinate bone articulates with four bones, the ethmoid, lachrymal, palate, and superior maxillary, and has no muscles attached to it.

THE VOMER.

The Vomer, so called from its shape resembling that of a plow-share, forms the posterior part of the nasal septum, but is usually bent to one side. It presents: A *superior border*, with a groove and two



FIG. 23.—THE VOMER. (Side view.)

wings (*alæ*), for articulation with the rostrum and vaginal processes of the sphenoid bone ; an *anterior border*, which is grooved for the ethmoidal plate and the nasal cartilage ; an *inferior border*, which is the longest, and articulates with the nasal crest of the superior maxillary and palate bones ; a *posterior border*, which is free and presents toward the pharynx ; *naso-palatine grooves*, laterally, for the naso-palatine nerves ; *furrows*, on the lateral surface, for nerve filaments and blood-vessels. The vomer articulates with six bones,—sphenoid, ethmoid, two superior maxillary, and two palate bones. It has no muscles attached to it.

CHAPTER IV.

MUSCLES.

MUSCLES are the fleshy parts of the body. They are the active organs of locomotion, and are composed of fibres bound together in bundles, or fasciculi, by delicate areolar tissue.

The muscular fibres of which each muscle is compounded are called ultimate fibres. Of these anatomists recognize two kinds—voluntary or animal fibres (striped), and involuntary or organic fibres (unstriped). The former are generally under the influence of the will, are of uniform size, and present transverse markings. They compose the muscles of the trunk and limbs, as well as those of the heart, urethra, internal ear, and, in part, those of the œsophagus; though the muscles of the heart are striped, they are not voluntary; the muscular coat of the urethra consists of two layers of plain, muscular fibre; the muscles of the internal ear are striped, but are not voluntary; in the upper part of the œsophagus the muscular fibres consist chiefly of the striped variety, but below they consist entirely of the involuntary or unstriped muscular fibre.

The involuntary fibres are not under volitional control, are not striped, are of smaller size and homogeneous structure. They are found in the digestive canal, uterus, and bladder. The voluntary muscles terminate in fibrous tissue, which is sometimes gathered together in bundles to form tendon, or is spread out in a membranous form, and is then called aponeurosis. By one or the other of these terminal forms almost all muscles are attached to those parts which it is their office to move.

The involuntary muscles are generally found interlacing freely around a cavity, which, by their contraction, they constrict, expelling its contents. Each muscle is closely though loosely invested by a sheath of cellular tissue, which also sends prolongations into the body of the muscle, investing each fibre and binding them together. The muscles of expression, which are especially interesting in their relation to prosthetic dentistry, are quite numerous, and are very closely connected with the subcutaneous tissue and the skin. Muscles are variously named, according to their form, long, broad, short, etc. These names sufficiently explain themselves. Other names are given them, depending on the arrangement of their fibres, their situation, number of divisions, office, etc. The muscles of the mouth, for example, are named elevators, depressors, sphincters, etc., according to their respective functions. For fuller explanation, students are referred to more exclusively anatomical works.

The *Fascia*, which everywhere invests the more delicate organs, is of two kinds—superficial, or fibro-areolar, and deep, or aponeurotic. The superficial fascia lies just beneath the skin, and covers nearly the entire surface of the body. It serves to connect the skin with the deep fascia, and furnishes a nidus for nerves and blood-vessels passing to the skin.

The deep fascia is composed of fibres arranged in a reticulated manner, forming a dense, inelastic membrane, which invests each muscle in a separate sheath. Sheaths are also formed from it for the vessels and nerves; and it serves also as points of attachment for the muscles.

Each striped muscular fibre is composed of two parts—a proper substance called the sarcous element, in which the contractile property resides, and a sheath or sarcolemma, a transparent, structureless membrane, in which is contained the contractile substance. These elementary fibres are connected by areolar tissue, with which a little fat is often associated. Lying between these fibres are blood-vessels, nerves, and lymphatics.

The sarcous element is a soft, granular material, on the varying relations of which granules to each other depend the alterations in appearance of the striæ. If they approach each other more closely in the direction of the length of the fibre than in its width, it will appear fibrillated; if the reverse, it will present the appearance of discs.

Muscles, like all other tissues, are developed from germinal matter which has undergone special metamorphosis, under the impulse of the parent cell, to construct this tissue. “Germinal matter” and “formed material” constitute the “elementary part,” according to Mr. Beale, or the muscular cell, of the other writers, from which the muscular fibre is formed. In the formed material, which is the constructed muscle, resides the power of contraction. The germinal matter, or constructive part, does not possess this property.

Following the arrangement of Mr. Gray, we shall divide the muscles which it is our purpose to describe into certain groups, as follows:—

I. NASAL GROUP.

Pyramidalis Nasi.
Levator Labii Superioris Alæque Nasi.
Levator Proprius Alæ Nasi Posterior.
Levator Proprius Alæ Nasi Anterior.
Compressor Naris.
Compressor Narium Minor.
Depressor Alæ Nasi.

2. SUPERIOR MAXILLARY GROUP.

Levator Labii Superioris Proprius.
Levator Anguli Oris.
Zygomaticus Major.
Zygomaticus Minor.

3. INFERIOR MAXILLARY GROUP.

Levator Labii Inferioris.
Depressor Labii Inferioris.
Depressor Anguli Oris.
Platysma Myoides.

ADJUNCT GROUP.

Musculus Risorius.

Orbicularis Oris.

Buccinator.

4. TEMPORO-MAXILLARY GROUP.

Masseter.

Temporal.

5. PTERYGO-MAXILLARY GROUP.

Pterygoideus Externus.

Pterygoideus Internus.

6. LINGUAL GROUP.

Genio-hyo-glossus.

Hyo-glossus.

Lingualis.

Stylo-glossus.

Palato-glossus.

7. PHARYNGEAL GROUP.

Constrictor Inferior.

Constrictor Medius.

Constrictor Superior.

Stylo-pharyngeus.

Palato-pharyngeus.

8. PALATAL GROUP.

Levator Palati.

Tensor Palati.

Azygos Uvulæ.

Palato-glossus.

Palato-pharyngeus.

I. NASAL GROUP.

Pyramidalis Nasi.

Levator Labii Superioris Alæque Nasi.

Levator Proprius Alæ Nasi Posterior.

Levator Proprius Alæ Nasi Anterior.

Compressor Naris.

Compressor Narium Minor.

Depressor Alæ Nasi.

The *Pyramidalis Nasi* is a triangular, muscular slip extended from the occipito-frontalis. It lies along the side of the nose, and blends by a tendinous expansion with the compressor naris.

The *Levator Labii Superioris Alæque Nasi* is also a triangular muscle, arising from the nasal process of the superior maxilla, its upper part. Passing down behind the muscle just described, it divides into two muscular slips, one of which is inserted into the cartilage of the ala of the nose, the other is continued to the angle of the mouth, where it blends with the orbicularis oris and levator labii proprius.

Beneath this muscle is a small muscular slip extending from the origin of the compressor naris to the nasal process, about an inch above it. It is called the “Musculus Anomalous,” or the “Rhomboides.”

The *Levator Proprius Alæ Nasi Posterior*, or Dilator Naris Posterior, extends from the nasal notch to the margin of the nostril.

The *Levator Proprius Alæ Nasi Anterior*, or the Dilator Naris Anterior, is situated a little in front of the last described muscle, and

arises from the cartilage of the wing of the nose, and is inserted into the integument near its margin.

The *Compressor Naris*, triangular in form, arises from the superior maxilla, a little above and external to the incisive fossa, and is attached to the fibro-cartilage of the nose, joining at the median line with its fellow of the opposite side.

The *Compressor Narium Minor* extends from the alar cartilage to the integument of the end of the nose.

The *Depressor Alæ Nasi* arises from the incisive fossa of the superior maxilla, and, dividing into two sets of fibres, ascending and descending, is inserted into the septum and posterior portion of nasal cartilage, and by some fibres of the latter into the back part of the orbicularis oris.

The facial nerve supplies all the muscles of this group.

Their respective actions are sufficiently explained by their names, except the pyramidalis, which draws down the inner angle of the eyebrow, and perhaps aids in dilating the nostril, and the compressores nasi, whose action is directly opposite to that implied by their names.

The contraction of the levator labii superioris alæque nasi gives to the face the expression of contempt.

2. SUPERIOR MAXILLARY GROUP.

Levator Labii Superioris Proprius.

Levator Anguli Oris.

Zygomaticus Major.

Zygomaticus Minor.

The *Levator Labii Superioris Proprius*, arises from the lower margin of the orbit, some of its fibres from the superior maxillary, others from the malar bone; they pass down to be inserted in the fleshy part of the upper lip.

The *Levator Anguli Oris* arises from the canine fossa, just below the infra-orbital foramen, and descends to the angle of the mouth, where it blends with the orbicularis oris, the zygomatici, and the depressor anguli oris muscles.

The *Zygomaticus Major* is a delicate fasciculus, arising from the malar bone, and finding attachment to the orbicularis and depressor anguli oris at the angle of the mouth.

The *Zygomaticus Minor* arises from the malar bone, just behind the maxillary suture, and passes downward and inward, to be inserted in the outer margin of the levator labii superioris, with which it is continuous.

These muscles are also supplied by the facial nerve.

The action of the levator muscles is described in their names. The zygomatici draw the lip upward and outward, as in laughing.

3. INFERIOR MAXILLARY GROUP.

Levator Labii Inferioris.	(Levator Menti.)
Depressor Labii Inferioris.	(Quadratus Menti.)
Depressor Anguli Oris.	(Triangularis Menti.)
Platysma Myoides.	

The *Levator Labii Inferioris* arises from the incisive fossa just external to the symphysis of the chin; it is a small, conoidal fasciculus, and is inserted into the integument of the chin.

The *Depressor Labii Inferioris* is a quadrilateral muscle, arising from the oblique line of the inferior maxilla, between the incisive fossa and mental foramen, and is attached to the integument of the lower lip, blending with the orbicularis and with its fellow of the opposite side.

The *Depressor Anguli Oris*, situated externally to the last-mentioned muscle, also arises from the external oblique line of the lower jaw, and is attached at the angle of the mouth to the orbicularis, levator anguli, and zygomaticus major muscles.

The facial nerve supplies this group.

Their action is indicated by their names.

The *Platysma Myoides* arises from the subcutaneous tissue over the pectoralis major, trapezius, and deltoid muscles, and passes obliquely over the clavicle and the side of the neck, its fibres terminating in the skin of the chin, the subcutaneous tissue of the cheek, the muscles at the corner of the mouth, the middle fibres being attached along the base of the jaw. It forms a defense for the neck, and is a muscle of expression from its functions of moving the skin, belonging to the class known as cutaneous muscles.

The *Musculus Risorius*, *Orbicularis Oris*, and *Buccinator* form a group closely connected with the superior and inferior maxillary groups.

The *Musculus Risorius* is considered by many as a part of the platysma myoides, the large subcutaneous muscle of the neck. It arises from the fascia over the masseter muscle, and, after passing horizontally forward, is inserted into the angle of the mouth, where it joins the orbicularis oris and depressor anguli oris. It gives the smile of derision.

The *Orbicularis Oris* surrounds the mouth, and forms a center from which muscles diverge and are fixed into the surrounding bones. It is the antagonist of all the muscles which move the lips, and has no bony origin or insertion. It is nearly an inch in breadth, and the prominence of the lips depends upon its size and thickness.

The *Buccinator* arises from the outer surface of the alveolar borders

of the superior and inferior maxillæ, corresponding to the molar teeth, and its fibres pass forward and are inserted into the angle of the mouth and the muscular structure of the lips. The buccinator is the principal muscle of the cheek, and, with the superior constrictor of the pharynx, forms a muscular wall for the sides of the mouth and pharynx. It is pierced by the duct of the parotid gland, which opens into the mouth opposite the superior second molar tooth. The functions of the buccinator are to expel air from the mouth by inflating the cheek, to widen the mouth, and to keep the food between the teeth during mastication. The facial nerve supplies this muscle, which is affected in facial paralysis. The buccinator muscle is covered by a thin layer of fascia known as the buccal fascia, which adheres closely to its surface and is attached to the alveolar border of the superior and inferior maxillæ. The density of this fascia prevents abscesses from readily discharging into the mouth or the pharynx.

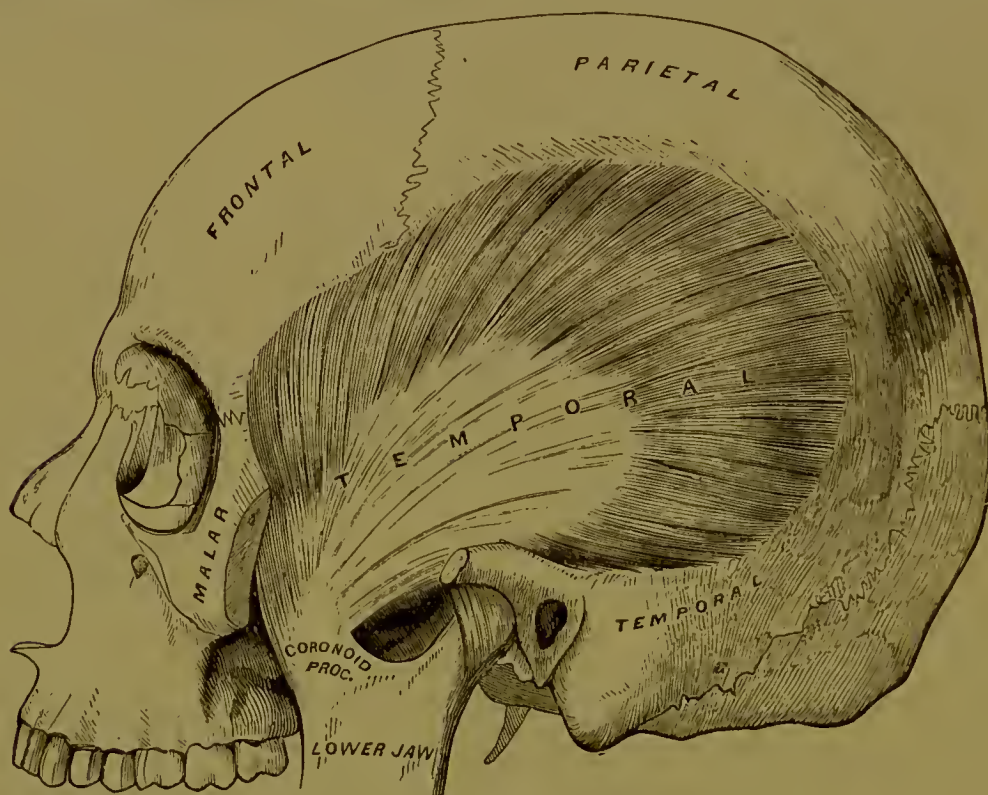


FIG. 24.

4. TEMPORO-MAXILLARY GROUP.

Temporal.

Masseter.

The *Temporal Muscle* (Fig. 24) is seen on the side of the head. It has its origin from the semicircular ridge, commencing at the external angular process of the os-frontis, and extending along this and the parietal bone; also from the surface below this ridge formed by the

frontal and squamous portion of the temporal and sphenoid bones ; likewise from the under surface of the temporal aponeurosis, and from a fascia covering this muscle ; and its fibres are inserted, after they have converged and passed under the zygoma, into the coronoid process of the lower jaw, surrounding it on every side by a dense, strong tendon.

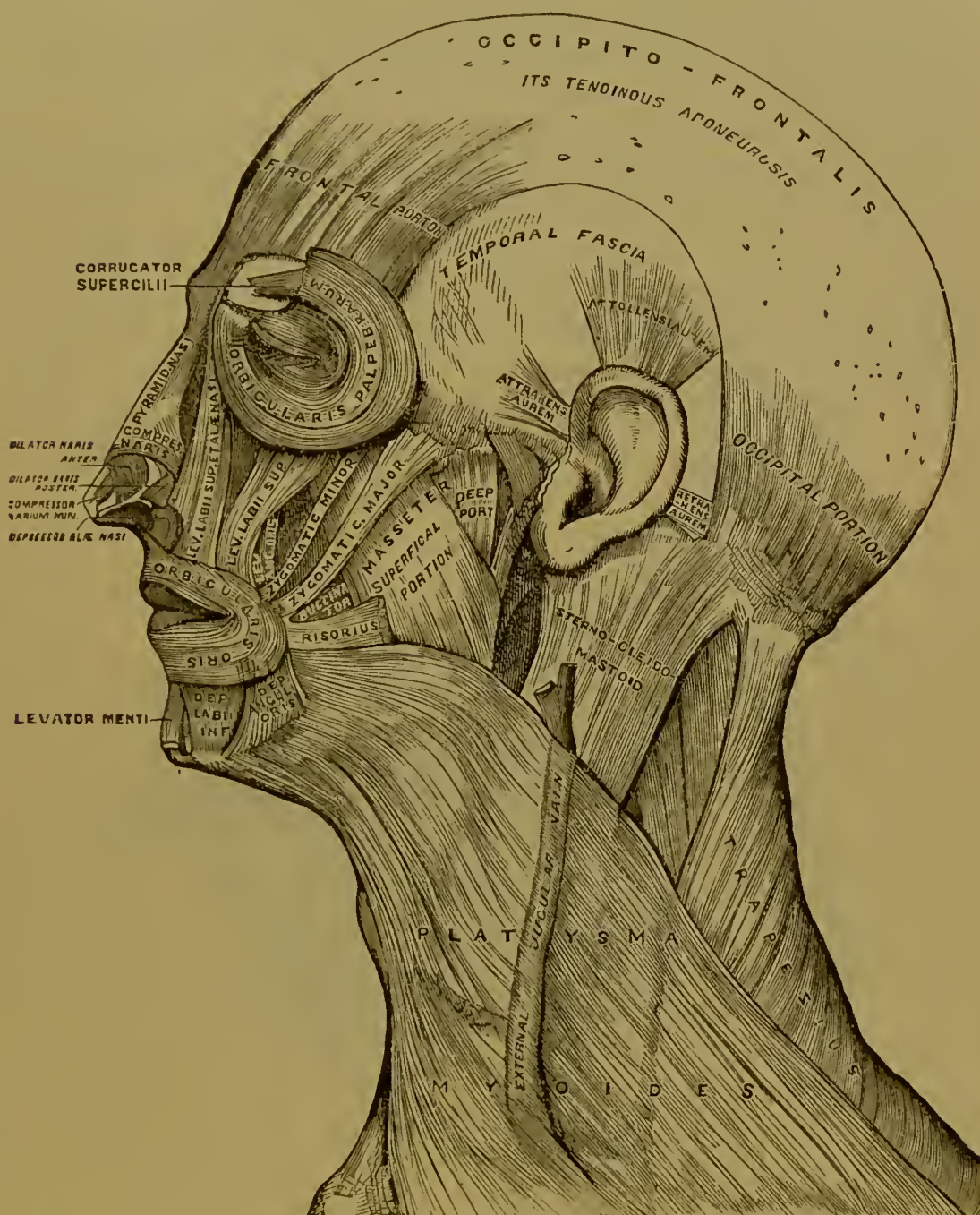


FIG. 25.

The *Masseter Muscle* (Fig. 25) is seen at the side and back part of the face, in front of the meatus externus, and lies directly under the skin. It arises by two portions: the one, anterior and tendinous, from the superior maxilla where it joins the malar bone; the other portion, mostly fleshy, from the inferior edge of the malar bone and the zygomatic arch as far back as the glenoid cavity, and is inserted,

tendinous and fleshy, into the external side of the ramus of the jaw and its angle as far up as the coronoid process.

The inferior maxillary nerve supplies both these muscles.

The office of the temporal muscle is to bring the two jaws together, as in the cutting and rending of the food.

The use of the masseter muscle, when both portions act together, is to close the jaw; if the anterior acts alone, the jaw is brought forward; if the posterior, it is drawn backward.

The use of the pterygoid muscle is to aid the temporal and masseter muscles in the trituration of the food. The external pterygoids carry the lower jaw directly forward when acting together; to one or the other side when acting separately. The internal pterygoid aids the masseter and temporal in bringing the lower jaw firmly up against the superior maxilla, and also assists in carrying the lower jaw forward.

The inferior maxillary nerve supplies these muscles, which form the pterygo-maxillary group, and which come next in order of description.

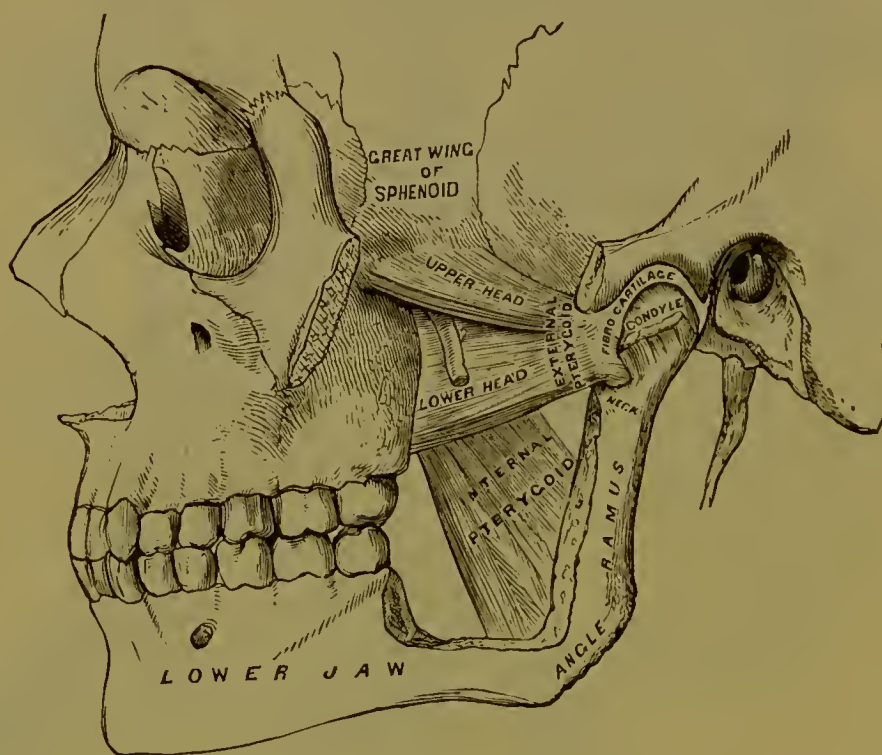


FIG. 26.

5. PTERYGO-MAXILLARY GROUP.

Pterygoideus Externus.

Pterygoideus Internus.

Pterygoideus Externus (Fig. 26) arises from the outer surface of the external plate of the pterygoid process of the sphenoid bone, from the tuberosity of the superior maxilla, and from the ridge on the sphenoid bone separating the zygomatic from the pterygoid fossa, and is in-

serted into the inner side of the neck of the lower jaw, and capsular ligament of the articulation.

Pterygoideus Internus arises, tendinous and fleshy, from the inner surface of the pterygoid plate, fills the greater part of the pterygoid fossa, and is inserted, tendinous and fleshy, into the inner face of the angle of the inferior maxilla and the rough surface above the angle.

The external one is triangular, having its base at the pterygoid process and running outward and backward to the neck of the condyle. The internal is strong and thick, placed on the inside of the ramus of the jaw, and running downward and backward to the angle.

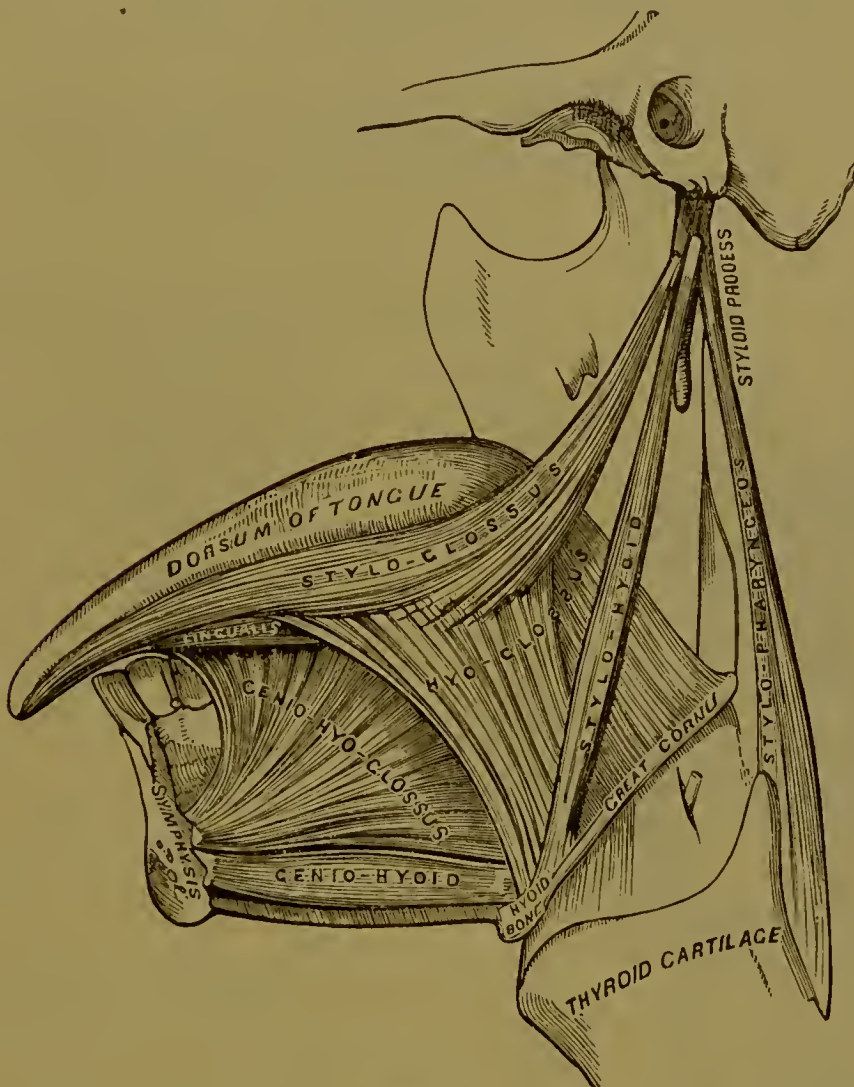


FIG. 27.

6. LINGUAL GROUP.

Genio-hyo-glossus.

Lingualis.

Hyo-glossus.

Stylo-glossus.

Palato-glossus.

The *Genio-hyo glossus* (Fig. 27) is attached, as its name implies, to the chin, hyoid bone, and tongue. It is a triangular, fan-like muscle, arising by its apex from the superior genial tubercle, and has its

inferior fibres running parallel with the genio-hyoid to be inserted into the hyoid bone, while its middle and anterior fibres are inserted into the under surface of the tongue its whole length.

The *Hyo-glossus*, a thin, broad, quadrilateral muscle, has its *origin* from the body, cornu, and appendix of the os-hyoides, and is *inserted* into the side of the tongue, forming the greater part of its bulk.

The *Lingualis* has its origin on the under surface of the tongue, extending from its base and hyoid bone to the apex, and so intermingling with the other muscles as to be considered rather a part of them than a distinct muscle.

The *Stylo-glossus* arises from the point of the styloid process and stylo-maxillary ligament. It is inserted into the side of the tongue near its root, its fibres running to the tip.

The *Palato-glossus* is more directly associated with the soft palate, and will consequently be described with the palatal group.

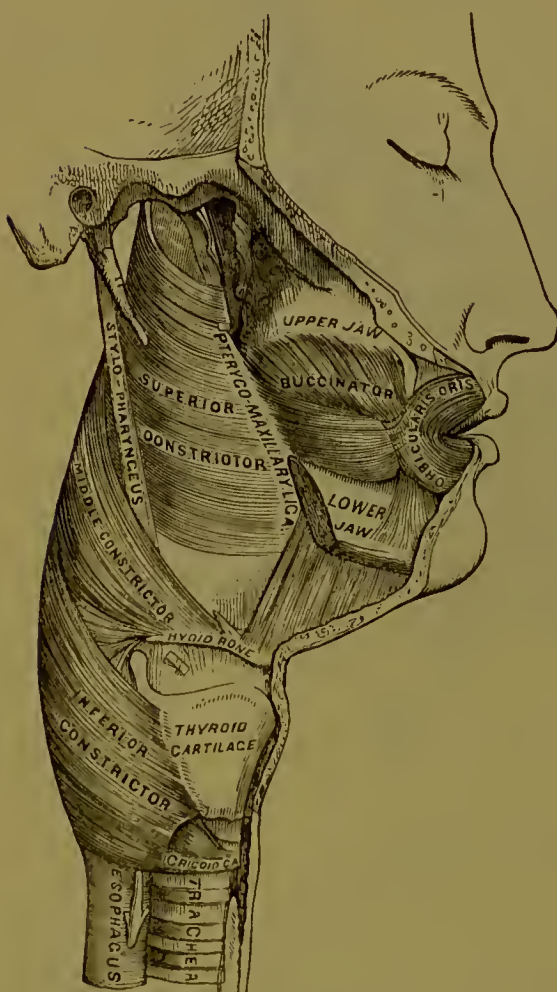


FIG. 28.

7. PHARYNGEAL GROUP.

Constrictor Inferior.
Constrictor Medius.
Constrictor Superior.
Stylo-pharyngeus.
Palato-pharyngeus.

The *Inferior Constrictor* of the pharynx (Fig. 28) arises from the side of the thyroid cartilage and its inferior cornu, and from the side of the cricoid cartilage, and is inserted with its fellow into the middle line on the back of the pharynx. This is the largest of the constrictor muscles, and overlaps the middle constrictor.

The *Middle Constrictor* of the pharynx (Fig. 28) arises from the appendix and both cornua of the os-hyoides, and from the thyro-hyoid ligament; its fibres ascend, run transversely, and descend, giving a triangular appearance; the upper ones overlap the superior constrictor,

the upper ones overlap the superior constrictor,

while the lower are beneath the inferior ; the whole pass back to be inserted into the middle tendinous line of the pharynx.

The *Superior Constrictor* (Fig. 28) arises from the cuneiform process of the occipital bone, from the lower part of the internal pterygoid plate of the sphenoid bone, from the pterygo-maxillary ligament, and from the posterior third of the mylo-hyoid ridge of the lower jaw, near the root of the last molar tooth. It is inserted with its fellow into the middle tendinous line at the back of the pharynx.

The *Stylo-pharyngeus* arises from the root of the styloid process, and is inserted into the side of the pharynx and corner of the os hyoides and thyroid cartilage. It is a long and narrow muscle, and passes to the pharynx between the upper and middle constrictors.

The *Palato-pharyngeus*, which forms the posterior pillar of the soft palate, is a long, fleshy muscle, wider at either extremity than in the middle, and arises from the soft palate by a divided fasciculus, between which points of attachment lies the levator-palati. It passes behind the tonsil, downward and outward, to be inserted into the posterior part of the thyroid cartilage, together with the stylo-pharyngeus.

The muscles of this group are supplied with nerves from the pharyngeal plexus and glosso-pharyngeal nerve ; an additional branch from the external pharyngeal nerve being sent to the inferior constrictor ; the palato-pharyngeus receives a branch from Meckel's ganglion.

These muscles are exercised in the act of deglutition, and also exert an influence in modulating the voice.

8. PALATAL GROUP.

The Levator Palati.

The Tensor, or Circumflex Palati.

Constrictor Isthmi-faucium, or Palati-glossus.

Palato-pharyngeus.

Azygos-uvulæ.

The *Levator Palati* (Fig. 29) arises from the point of the petrous portion of the temporal bone and adjoining portion of the Eustachian tube, descends, and is inserted into the soft palate.

The *Tensor*, or *Circumflexus Palati*, arises from the base of the pterygoid process of the sphenoid bone and from the Eustachian tube ; it descends in contact with the internal pterygoid muscle to the hamulus, round which it winds, and is inserted into the soft palate, where it expands and joins its fellow.

The *Constrictor Isthmi-faucium*, or *Palato-glossus*, occupies the anterior lateral half arches of the palate ; it arises from the side of the tongue near its root, and is inserted into the velum near the uvula.

The *Palato-pharyngeus* has already been described with the muscles of the pharyngeal group.

The *Azygos Uvulae* arises from the posterior spine of the palate bones at the termination of the palate suture, runs along the central line of the soft palate, and ends in the point of the uvula. It raises and shortens the uvula.

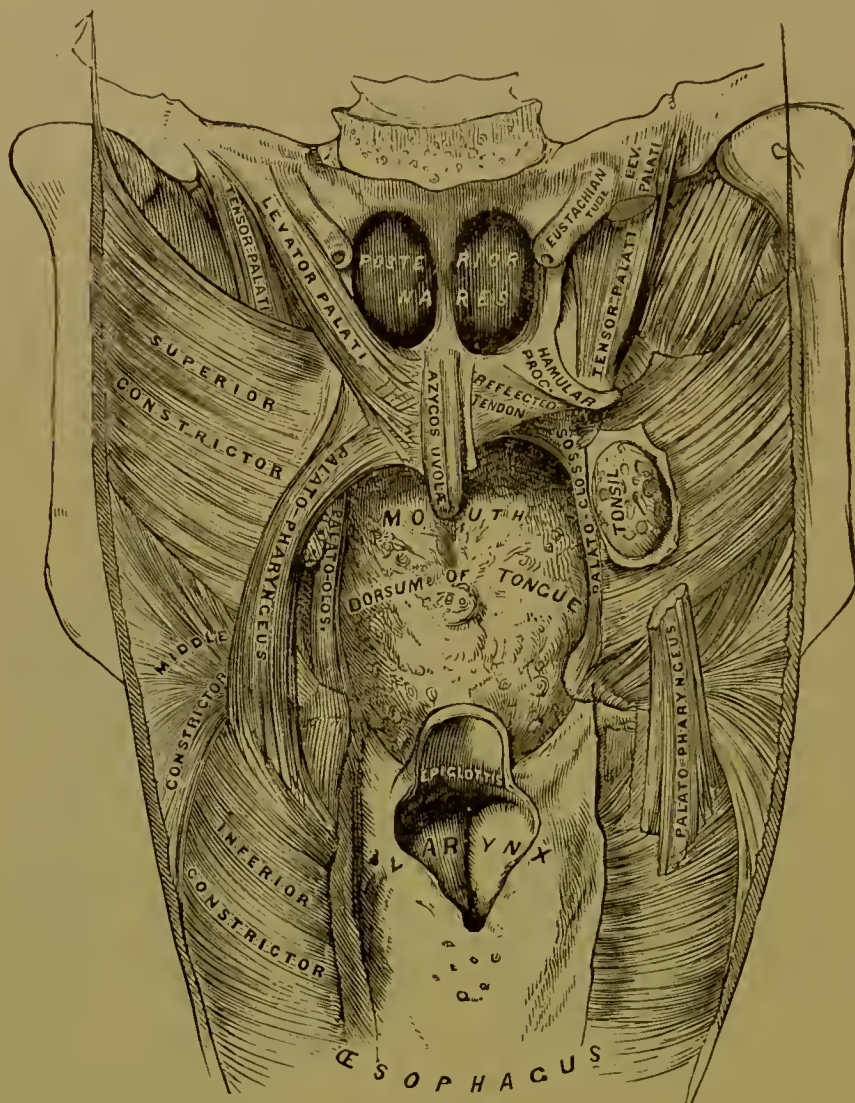


FIG. 29.

It is thus seen that the various muscles of the soft palate are all concerned, more or less, in conducting the food into the pharyngeal cavity. The elevators raise the palate, and at the same time protect the posterior nares from regurgitation of the food; while the tensor puts it on the stretch, and after it has passed the velum, the constrictor isthmi-faucium and palato-pharyngeus draw the palate down, and thus close the opening into the mouth; after which the food, as already mentioned, is grasped by the constrictor muscles of the pharynx and conveyed into the oesophagus.

The *Soft Palate* is a movable curtain, composed of mucous membrane, inclosing five muscles on each side, known as the muscles of the soft palate, namely: the levator palati, tensor palati, azygos uvulæ, palato-glossus, and palato-pharyngeus. It is situated at the back part of the mouth between this cavity and the pharynx, is connected above to the posterior edge of the hard palate, and laterally to the side of the tongue and pharynx.

By this arrangement, the soft palate has the appearance of a lunated or arched veil between the cavity of the mouth and the pharynx.

In the center of this arch an oblong body is suspended, called the uvula, which divides the soft palate into lateral half arches, that pass on either side from the uvula to the root of the tongue.

There is also seen passing from the uvula on each side to the pharynx two other arches, which, from being behind the first, are called the posterior arches or pillars.

Between the anterior and posterior pillars, on either side, is a triangular interval containing the tonsil glands.

The *Fauces* are the straits or passage leading from the mouth to the pharynx; and the space included between the soft palate above, the half arches or tonsils on either side, and the root of the tongue below, is called the isthmus of the fauces.

The *Tonsils* are two bodies, each about the size of an almond, seen at the root of the tongue on its sides, occupying the cavity between the anterior and posterior arches. They consist of a group of compound follicular glands, forming somewhat oval bodies, whose enlargement constitutes an obstacle to deglutition, and by their locality near the mouths of the Eustachian tubes frequently cause obstruction and deafness.

ARTICULATIONS.

Articulation is a term used in Anatomy to denote the various modes of union between the bones of the skeleton. Articulations are classed under three general heads, namely—movable joints, immovable joints, and joints of a mixed order, the latter being somewhat movable without much relative displacement of the contiguous surfaces. The lower jaw is an example of a movable articulation which is known as the—

Temporo-maxillary Articulation (Figs. 30 and 31).—The inferior maxillary bone articulates with the anterior portion of the glenoid cavity of the temporal bone, forming the temporo-maxillary articulation. This joint consists of the convex condyloid head or process of the inferior maxillary bone, the concave surface of the glenoid fossa, the interarticular fibro-cartilage, a double synovial membrane, and a loose capsular ligament.

The *Capsular Ligament* is a very loose sac, attached above to the circumference of the glenoid cavity, and in front to the articular root



FIG. 30.

of the zygoma; below it embraces the neck of the inferior maxillary bone, immediately below the head or condyloid process.

The *Interarticular Fibro-cartilage* is an ovoid plate placed between



FIG. 31.

the bones, and is supported in position by a circumferential attachment to the common capsule, the external lateral ligament, and to the tendon of the external pterygoid muscle. Below its face is concave, corresponding with the convexity of the condyle: above it is concave

in front and convex behind, corresponding with the glenoid cavity proper and the articular eminence. The composition of the circumference is fibrous with a cartilaginous center, being frequently quite soft and sometimes perforated.

The *Synovial Membranes*, one above and the other below the inter-articular fibro-cartilage, are the lubricating membranes, and in form are similar to two small sacs. They secrete the synovia, a fluid which resembles the white of an egg, but which is more oily and resistive in its nature.

The *Internal Lateral Ligament* descends from the spinous process of the great wing of the sphenoid bone, and is attached to the inner surface of the ramus.

The *Stylo-maxillary Ligament* passes behind from the styloid process of the temporal bone to be inserted just above the angle.

The *External Lateral Ligament* has its origin from the zygoma, and passes obliquely downward and backward to be inserted about the neck of the condyle; it is a short, somewhat triangular-shaped band of fibrous tissue, and assists in forming the common capsule. Externally it is very superficial, being covered only by the integuments, except in cases where the parotid gland overlaps it.

CHAPTER V.

THE ARTERIES AND VEINS OF THE MOUTH.

THE arteries that supply the mouth come from the external carotid. This is a division of the common carotid which arises on the right side from the arteria innominata, and on the left from the arch of the aorta; after passing up the neck on either side, along the course of the sterno-cleido-mastoid muscles, it divides, on a level with the top of the thyroid cartilage, into its two great branches—the external and internal carotid arteries.

The *Internal Carotid Artery* has a tortuous course; is first to the outside and behind the external carotid; then ascends in front of the vertebral column by the side of the pharynx and behind the digastric and styloid muscles to the carotid foramen in the petrous portion of the temporal bone; thence it traverses the canal in this bone and enters the brain, supplying it with most of its vessels, not giving any to the mouth.

The *External Carotid* extends from the top of the larynx to the neck of the condyle of the lower jaw; at first anterior and on the inside of

the internal carotid, it soon gets to the outside, then passes under the digastric and stylo-hyoid muscles and lingual nerve, becomes imbedded in the parotid gland, and terminates between the neck of the inferior maxilla and the auditory meatus in the temporal and internal maxillary arteries.

The branches of the external carotid with which we have to do are the—

Lingual.

Facial.

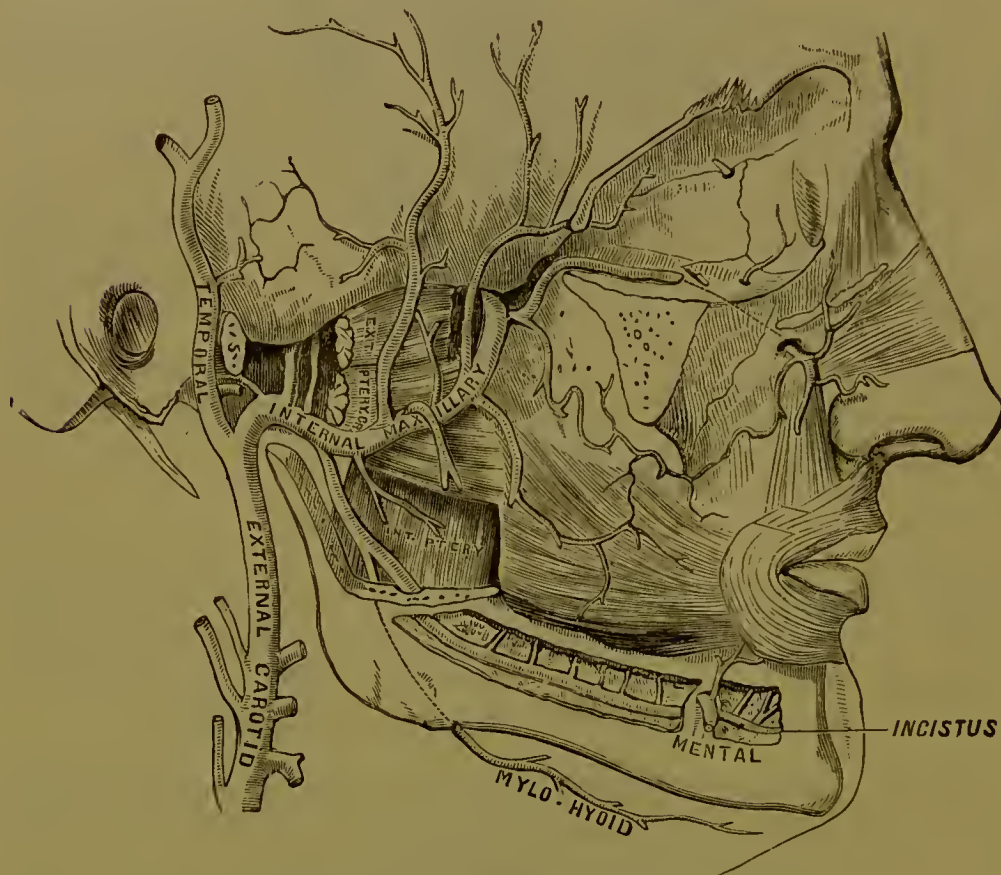


FIG. 32.

Ascending Pharyngeal.

Temporal.

Internal Maxillary.

The *Lingual Artery* arises from the external carotid, between the superior thyroid and facial; passing obliquely up to the great corner of the hyoid bone, it runs parallel with, and ascending perpendicularly to, the base of the tongue, continues its course to the tip of that organ, under the name of the ranine artery. This part of the artery lies just beneath the mucous membrane, and is in danger of being wounded in division of the frænum in children. This accident may be avoided by using blunt-pointed scissors, and directing the points downward and backward.

The hypo-glossal nerve accompanies this artery.

The branches of the lingual artery with which we are concerned are the—

Dorsalis Linguae.

Sublingual.

Ranine.

The *Dorsalis Linguae* arises from the lingual artery, beneath the hypo-glossus muscle, and is distributed to the tonsil, epiglottis, soft palate and mucous membrane of the tongue.

The *Sublingual* arises from the lingual at the point of bifurcation, near the anterior margin of the hyo-glossus muscle, and passes forward to be distributed to the sublingual gland, to the mucous membrane of the mouth and gums, and to the neighboring muscles.

The *Ranine* may be considered the continuation of the lingual. It passes along the inferior surface of the tongue, just beneath its mucous membrane. At the tip of the tongue it anastomoses with its fellow of the opposite side. It is accompanied by the gustatory nerve.

The *Facial Artery* is the third branch of the external carotid. It ascends to the submaxillary gland, behind which it passes on the body of the lower jaw; thence it goes in front of the masseter muscle to the angles of the mouth, and finally terminates at the side of the nose by anastomosing with the ophthalmic arteries.

In its course it gives off the submental, inferior labial, superior and inferior coronary arteries, which mainly supply the elevators, depressors, and circular muscles of the mouth. The branches of the facial artery are divided into two sets:—

Cervical Branches.

Inferior or Ascending Palatine.
Tonsillitic.
Submaxillary.
Submental.

Facial Branches.

Muscular.
Inferior Labial.
Inferior Coronary.
Superior Coronary.
Lateralis Nasi.
Angular.

The *Inferior Palatine* passes up between the stylo-glossus and stylo-pharyngeus muscle, which it supplies, to give branches to the tonsil, Eustachian tube, soft palate and palatine glands, anastomosing with the tonsillitic artery and with a branch of the internal maxillary.

The *Tonsillitic Artery* is distributed to the tonsil and root of the tongue.

The *Submaxillary* supplies the submaxillary gland, together with the neighboring lymphatic glands, muscles and integuments.

The *Submental* is the largest of the cervical branches of the facial

artery; it is given off from it just as it emerges from the submaxillary gland, and, passing along the lower border of the inferior maxilla, is distributed to the muscles attached to the jaw, and terminates in a superficial and deep branch; the former of which is distributed to the depressor labii inferioris and integument, anastomosing with the inferior labial; the latter is also distributed to the lip, and anastomoses with the inferior labial and mental arteries.

The *Facial* branches are distributed to the muscles of the face. The muscular to the pterygoid, masseter and buccinator muscles. The superior coronary to the upper lip, giving branches to the septum and ala nasi. The inferior coronary passes to the lower lip, and anastomoses with its fellow of the opposite side. The lateralis nasi supplies the wing and back of the nose. The angular is the terminal branch of the facial. It supplies the cheek, lachrymal sac and orbicularis palpebrarum muscle, and terminates by anastomosing with the ophthalmic by its nasal branch.

The *Ascending Pharyngeal*, the smallest of the external carotid branches, is given off from the posterior part of the external carotid, passes up beneath its other branches and the stylo-pharyngeus muscle to the base of the skull; it has three sets of branches—the external, meningeal and pharyngeal. To the latter only will attention be directed.

The *Pharyngeal* branches are three or four in number, two of which are distributed to the middle and inferior constrictors and to the stylo-pharyngeus, and their mucous membrane. The largest branch supplies the tonsil, Eustachian tube and soft palate, substituting the palatine branch of the facial when it is absent or of small size.

The *Temporal Artery* gives off a transverse facial branch just before it emerges from the parotid gland, which is distributed to that gland, the masseter muscle and the integument, terminating by anastomosis with the facial and infra-orbital arteries.

The *Internal Maxillary Artery* commences in the substance of the parotid gland; then goes horizontally behind the neck of the condyle of the lower jaw to the pterygoid muscles, between which it passes, and then proceeds forward to the tuberosity of the superior maxillary bone; from thence it takes a vertical direction upward between the temporal and external pterygoid muscles to the zygomatic fossa, where it again becomes horizontal, and finally ends in the speno-maxillary fossa by dividing into several branches.

The branches of this artery which we shall describe are the—

Inferior Dental.
Infra-orbital.

Alveolar.
Descending Palatine.

The *Inferior Dental Artery* enters the inferior dental foramen of the lower jaw, passes along the dental canal beneath the roots of the teeth; sending up, in its course, a twig through the aperture of each to the pulp of the teeth, and finally escapes at the mental foramen on the chin; a branch of it, however, continues forward to supply the incisors. After emerging from the mental foramen, it supplies the muscles and integument of the chin and anastomoses with the inferior labial, submental, and inferior coronary arteries. Before entering the dental foramen a large branch, the mylo-hyoid, which lies in a groove of the same name on the inner surface of the maxillary bone and is lost on the under surface of the mylo-hyoid muscle, is given off.

The *Alveolar* is given off from the internal maxillary by a trunk common to it and the infra-orbital, just before it enters the sphenomaxillary fossa. At the tuberosity of the superior maxillary bone it divides into numerous branches, some of which, passing into the alveolar foramina, supply the bicuspid and molar teeth; others pierce the bone to supply the antrum, while some are distributed to the gums.

The *Infra-orbital Artery* enters the infra-orbital canal, traverses its whole extent, and comes out at the foramen of the same name, upon the face; just before it emerges it sends through the anterior dental canal a twig for the incisors and cuspids, having previously given branches to the inferior rectus and inferior oblique muscles and to the lachrymal gland; also other branches to the lining membrane of the antrum. After escaping from the orbit, it supplies the lachrymal sac and neighboring tissues and anastomoses with the facial, nasal branch of the ophthalmic, and with the transverse facial and buccal branch.

The *Descending Palatine* passes along the posterior palatine canal, accompanied by palatine branches of Meckel's ganglion; emerging thence it runs along a groove on the inner border of the alveoli, and is distributed to the mucous membrane of the hard palate, to the gums and the palatine glands. In the posterior palatine canal it gives off branches, which pass along the accessory palatine canal to be distributed to the soft palate. In front it terminates in a small branch which enters the anterior palatine canal, through which it passes to reach the septum naris, where it unites with a branch of the sphenopalatine.

The *Veins* correspond so nearly, both in name and course, with the arteries, that a description of them would only be a repetition of what has been said; suffice it, therefore, to observe that there are two companion veins with every considerable artery, and that the venous branches are mostly collected at the angle of the jaw into a common

trunk called the external jugular vein, which passes down the neck in the course of the fibres of the platysma muscle, and terminates in the subclavian vein at the posterior edge of the sterno-mastoid muscle.

The office of the veins is to return the blood to the heart.

CHAPTER VI.

THE NERVES OF THE MOUTH.

THE *Cranial Nerves* pass in pairs through the foramina in the base of the skull. According to the order of succession from before backward, they are known as the first, second, third, fourth, fifth, sixth, seventh, eighth, ninth, tenth, eleventh, and twelfth pairs.

The nerves supplying the mouth belong to the fifth pair, and the portio dura of the seventh pair or facial nerve.

The *Fifth* (Trigemini) is the largest of the cranial nerves, and gives sensibility to all the organs concerned in the primary stages of digestion.

This nerve will also be found to be a compound nerve, having motor filaments as well as sensitive, and thereby giving motion as well as sensation. It is also a nerve of special sense.

It is first seen at the side of the pons Varolii near its junction with the crura-cerebelli, but its origin is much deeper and further back. It arises by two unequal roots, one of which may be traced through the pons Varolii into the lateral tract behind the olivary body; the smaller, or *motor root*, is lost in the medulla oblongata. From its origins this nerve has been called a cranial-spinal nerve.

These two fasciculi, the one anterior and the other posterior, constitute the fifth nerve, which consists of eighty or one hundred filaments that pass forward and outward, in a canal formed of dura mater, to a depression on the anterior surface of the petrous bone.

At this point it spreads into a ganglion, called the Gasserian ganglion, on the under surface of which is seen the anterior root; but it has no intimate connection with the ganglion, and can be traced on, as will be presently shown, to the inferior maxillary nerve.

The Gasserian ganglion receives filaments from the carotid plexus of the sympathetic, and gives off several minute branches to the dura mater and tentorium cerebelli. Three large branches are given off from its anterior border, the ophthalmic and superior and inferior maxillary. The ophthalmic and superior maxillary are exclusively nerves of sensation, their fibres being derived entirely from the pos-

terior or sensory root, whilst the inferior maxillary receives fibres from both roots, and is consequently more variously endowed.

The *Ophthalmic Nerve* is a short trunk that enters the orbit through the foramen lacerum superius. It supplies the eyeball, the mucous membrane of the eye and nose, and the lachrymal gland, also the muscles and integument of the eyebrow and forehead. It is a sensitive nerve ;

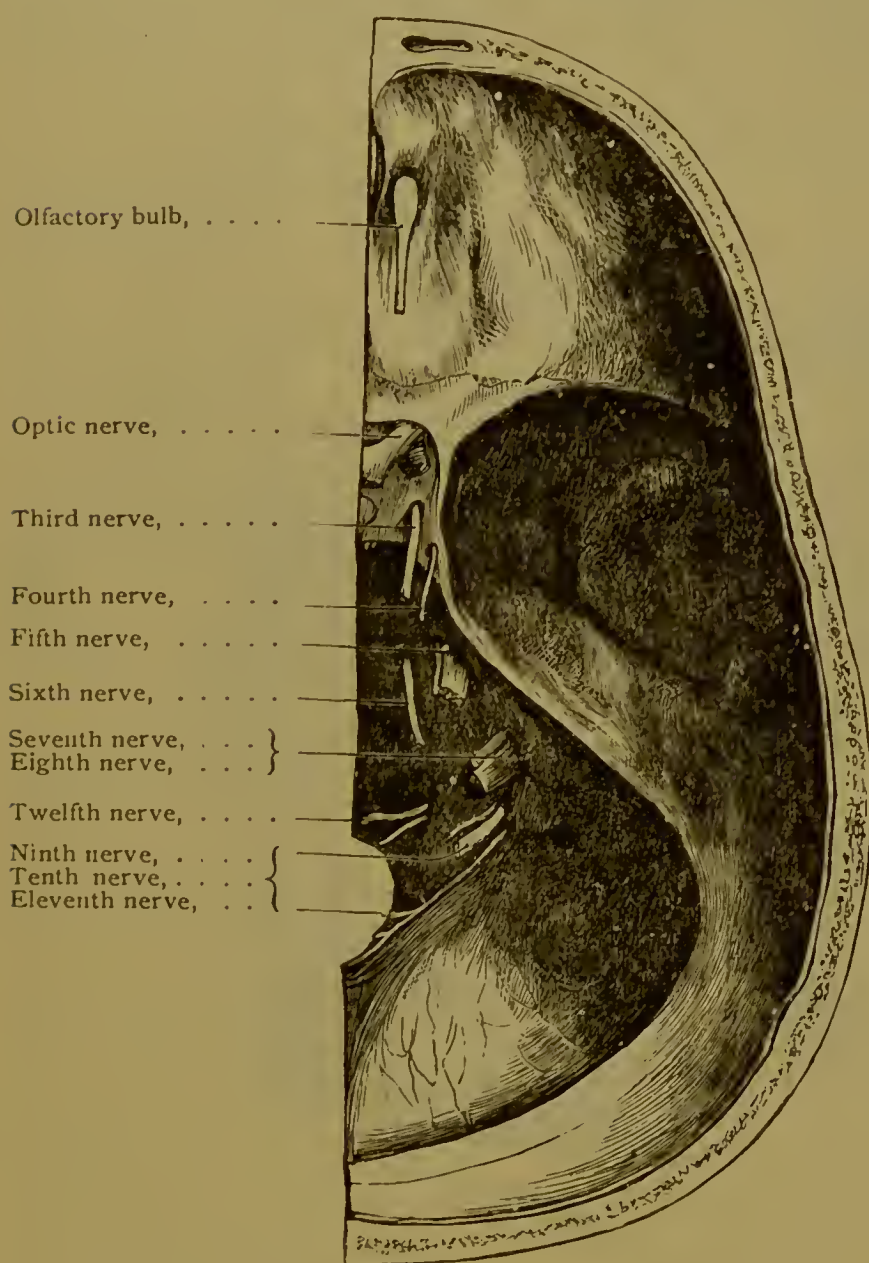


FIG. 33.—DIAGRAM OF THE EXIT OF THE CRANIAL NERVES.

is the first given off from the Gasserian ganglion, and is the smallest of the three branches. It receives a few filaments from the cavernous plexus of the sympathetic, and divides into three principal branches—

1. The Frontal,
2. The Lachrymal, and
3. The Nasal.

The *Frontal*, which is the largest branch of the ophthalmic, passes along the roof of the orbit to the supra-orbital foramen, through which it passes, and is then called the supra-orbital nerve, and is spent on the muscles and integuments of the forehead. It gives off several branches in its course.

The *Lachrymal*, the smallest branch of the ophthalmic, generally arises by two branches, one from the fourth nerve and the other from the ophthalmic. It enters the orbit through the sphenoidal

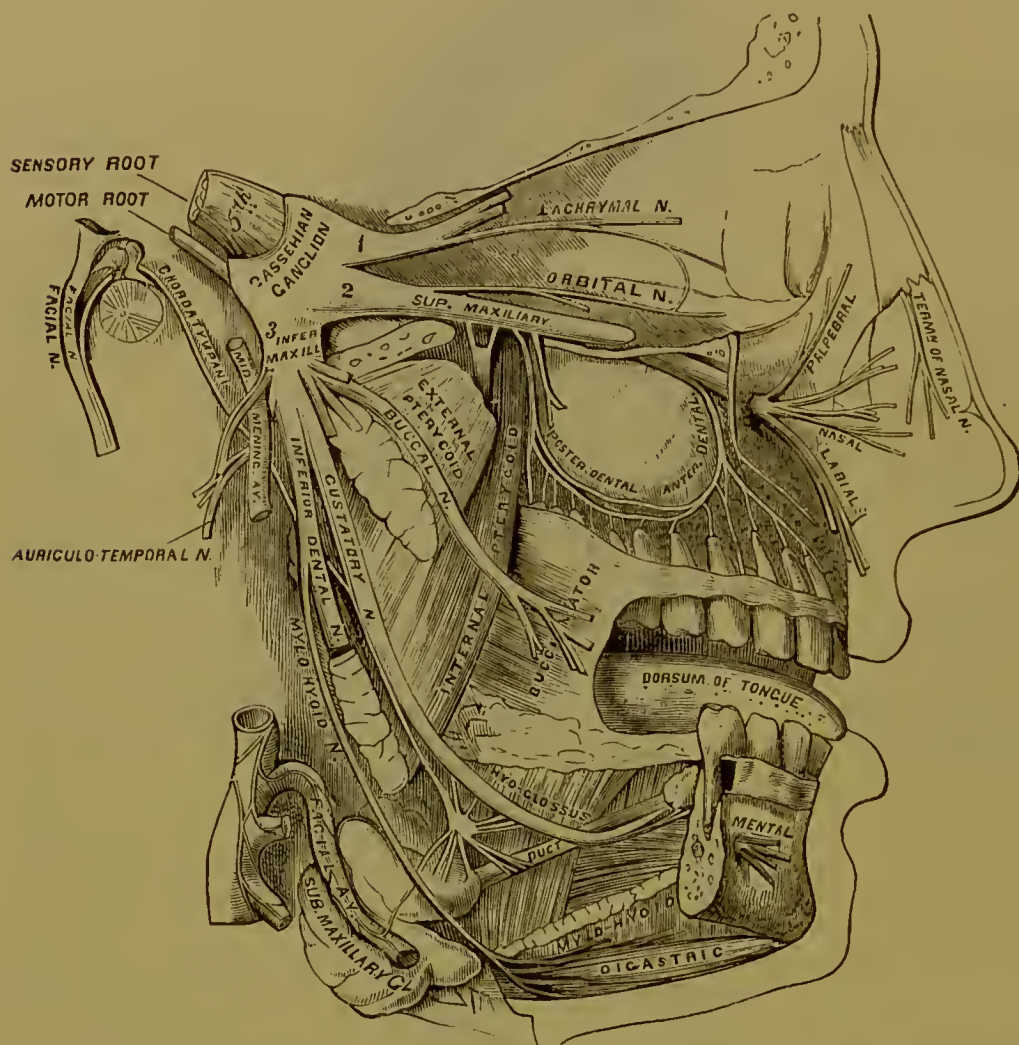


FIG. 34.

fissure, receives a communicating branch from the superior maxillary, and is finally distributed to the lachrymal gland, taking the outward direction, and sending branches in its course to the upper eyelid, conjunctiva, and other parts, receiving on the eyelid branches from the facial.

The *Nasal* takes its direction along the inner side of the orbit to the anterior ethmoidal foramen, through which it passes into the cranium, on the upper surface of the cribriform plate of the ethmoidal

bone; descends by the side of the crista-galli through a slit-like opening into the nose, and there terminates by filaments which are spent upon the septum, mucous membrane, anterior nares, etc. It sends off several branches in its course; one in particular to the lenticular ganglion at the bottom of the eye, others to the caruncula lachrymalis, lachrymal sac, conjunctiva, etc.; but as these do not belong to the mouth and dental apparatus, we will pass to the second great division of the fifth.

The Superior Maxillary Nerve.—This nerve proceeds from the middle of the Gasserian ganglion, passes through the foramen rotundum of the sphenoid bone into the pterygo-maxillary fossa; here it enters the canal of the floor of the orbit—the infra-orbital canal—traverses its whole extent, and emerges on the face at the infra-orbital foramen, where it terminates in numerous filaments in the muscles and integuments of the upper lip, cheek, lower eyelid and side of the nose.

The superior maxillary nerve supplies the upper jaw, and gives off many important branches, which are as follows:—

In the pterygo-maxillary fossa two branches descend to a small reddish body called the ganglion of Meckel, or the sphenopalatine ganglion, situated on the outer side of the nasal or vertical plate of the palate bone.

From this ganglion proceed three sets of branches:—

1. Inferior, Descending or Palatine Nerves.
2. Nasal or Sphenopalatine.
3. Posterior, Pterygoid or Vidian.

The *Palatine Nerves* descend through the posterior palatine canal, come out at the posterior palatine foramen, along with an artery of the same name, and supply with filaments the soft palate, uvula, tonsils, the roof of the mouth, and the inner alveoli and gums.

The *Nasal Nerves* enter the nose through the sphenopalatine foramen, and divide into several filaments, which enter the mucous membrane covering the upper and lower turbinated bones and vomer; one long branch can be traced along the septum nasi, as far as the foramen incisivum, where it meets the anterior palatine branches in a ganglion called the naso-palatine.

The *Vidian*, or *Pterygoid*, passes backward from the ganglion of Meckel through the pterygoid canal at the root of the pterygoid process; then enters the cranium through the foramen lacerum anterius, and divides into two branches, one of which enters the carotid canal and unites with the sympathetic branches of the superior cervical ganglion, thus connecting this ganglion with the ganglion of Meckel.

The other, the proper vidian nerve, enters the vidian foramen or hiatus Fallopii in the petrous bone, joins the portio dura nerve, accompanies this as far as the back part of the tympanum; then leaves it, enters the cavity of the tympanum, and receives there the name of *Chorda Tympani*. It leaves this cavity by the glenoid fissure, then joins the gustatory nerve, continues with it to the submaxillary gland, where it leaves it, and is lost in the submaxillary ganglion, situated at the posterior part of the submaxillary gland.

The exceedingly intricate course of the vidian nerve is interesting from the number of communications which it establishes between different and distant parts; for it unites the ganglion of Meckel with the superior cervical ganglion of the sympathetic, and both with the submaxillary ganglion; it also connects the superior and inferior maxillary nerves to one another and to the portio dura.

The *Superior Maxillary Nerve* gives off next in the speno-maxillary fossa—

1. The Orbital.
2. The Posterior Dental.
3. The Anterior Dental.

The *Orbital* enters the orbit through the speno-maxillary fissure, and then sends off a *malar* and *temporal* branch, which pass out through the malar bone; the first supplying the cheek, the latter accompanying the temporal artery to the integuments of the side of the head, receiving filaments from the facial and auriculo-temporal branch of the inferior maxillary.

The *Posterior Dental Nerves*, two in number, descend on the tuberosity of the superior maxillary bone, and enter the posterior dental canals to supply the bicuspid and molar teeth; one branch penetrates the antrum and courses along the outer wall, anastomosing with the anterior dental nerves, while another runs along the alveolar border, supplying the gums.

The *Anterior Dental* is given off from the superior maxillary, just before it escapes from the infra-orbital foramen. It anastomoses with the posterior dental, and sends filaments to the incisor, canine, and first bicuspid teeth; others are sent to the mucous membrane of the inferior meatus.

This nerve now emerges, as before mentioned, at the infra-orbital foramen, between the levator labii superioris alæque nasi and levator anguli muscles, dividing here into many branches, some of which ascend to the nose and eyelids, others pass downward and outward to the lip and cheek, anastomosing with the nasal branch of the ophthalmic and the facial branches of the portio dura.

Inferior Maxillary Nerve.—This nerve forms the third great division of the fifth. It is the largest branch, and passes from the ganglion of Gasser, through the foramen ovale of the sphenoid bone, to the zygomatic fossa.

This nerve, as stated, is attached to the anterior or motor root, and they come together on the outside of the foramen ovale; then in the zygomatic fossa, the inferior maxillary nerve divides into two branches:—

1. Anterior.
2. Posterior.

The *Anterior* is the motor branch, and gives off the following filaments to the several muscles:—

1. *Masseteric*, crossing the sigmoid notch to the masseter muscle.
2. *Temporal*, anterior and posterior deep, to the temporal muscle and fascia.
3. *Buccal*, to the buccinator, external pterygoid, and temporal muscles.
4. *Pterygoid*, to the pterygoid muscles.

The *Internal* division of the inferior maxillary nerve consists of three branches, all of which are sensitive; they are:—

1. The Anterior Auricular.
2. The Gustatory.
3. The Inferior Dental.

The *Anterior Auricular* passes behind the neck of the lower jaw and in front of the meatus of the ear, and ascends through the parotid gland, over the zygoma, along with the temporal artery, and divides into anterior and posterior branches.

In its course it unites with the facial nerve, and supplies the parotid gland, the articulation of the lower jaw, the meatus, and cartilages of the ear and side of the head.

The *Gustatory Nerve*, the nerve of the special sense of taste, immediately after its origin sends a branch to the inferior dental; it then descends between the pterygoid muscles, where the chorda tympani joins it; it now passes along the ramus of the lower jaw, covered by the internal pterygoid muscle, then above the submaxillary glands, and forward above the mylo-hyoid and between it and the hyo-glossus muscles, accompanied by the duct of Wharton; and finally ascends above the sublingual gland to the lateral, inferior, and anterior parts of the tongue.

In its course, the following branches are given off by this nerve:—

“First, one or two small filaments to the internal pterygoid muscle. Second, several to the tonsils, to the muscles of the palate, to the

upper part of the pharynx, and to the mucous membrane of the gums. Third, the chorda tympani, and some accompanying filaments to form a plexus, which supplies the submaxillary gland. Fourth, a few branches which descend along the hyo-glossus muscle to communicate with the ninth or lingual nerve. Fifth, a fasciculus of nerves to the sublingual gland and to the surrounding mucous membrane. Lastly, at the tongue it divides into several branches; some pass deep into the tissue of this organ; others, firm and soft, rise toward its surface, and are lost in the mucous membrane and in a small conical papilla near its tip."

The *Inferior Dental Nerve* passes between the pterygoid muscles, then along the ramus of the lower jaw under the pterygoideus internus to the inferior dental foramen, which it enters along with an artery and vein; it now traverses the inferior dental canal, sending twigs into all the roots of the molars and bicuspid. Opposite the mental foramen it divides into two branches; the smaller is continued forward in the substance of the jaw to supply the roots of the cuspids and incisors; while the larger comes out at the mental foramen, is distributed to the muscles and integuments of the lower lip, and finally communicates with the facial nerve.

The inferior dental, just as it enters the posterior dental foramen, gives off the *mylo hyoid* nerve; this passes forward in a groove of the lower jaw, and supplies the mylo-hyoid and digastric muscles, and occasionally the submaxillary gland.

The Facial Nerve.—The seventh or facial nerve (*portio dura*) is the last nerve to be noticed as particularly belonging to the mouth.

This nerve arises from the medulla oblongata between the olivary and restiform bodies, close behind the lower margin of the pons Varolii; it then passes forward and outward with the portio mollis to the foramen auditorium internum, which it enters and passes on to the base of this opening; here these two nerves separate, the portio mollis going to the labyrinth of the ear, while the facial enters the aqueduct of Fallopius, in which it is joined by the vidian. Within the aqueductus Fallopii it gives off two branches—the tympanic and chorda tympani. The former supplies the stapedius muscle. The latter passes along a distinct canal and enters the cavity of the tympanum near the attachment of the membrana tympani, where it is covered by mucous membrane. It escapes from this cavity by the inner side of the Glaserian fissure; after receiving a communicating branch from the gustatory nerve it passes to the submaxillary gland, then joining the submaxillary ganglion it is lost in the lingual muscle. The facial then goes in a curved direction outward and backward behind the tympanum, where it parts with the vidian, and proceeds on

to the stylo-mastoid foramen, from which it emerges. At this point it sends off three small branches:—

1. The Posterior Auricular,
2. The Stylo-hyoid, and
3. The Digastric.

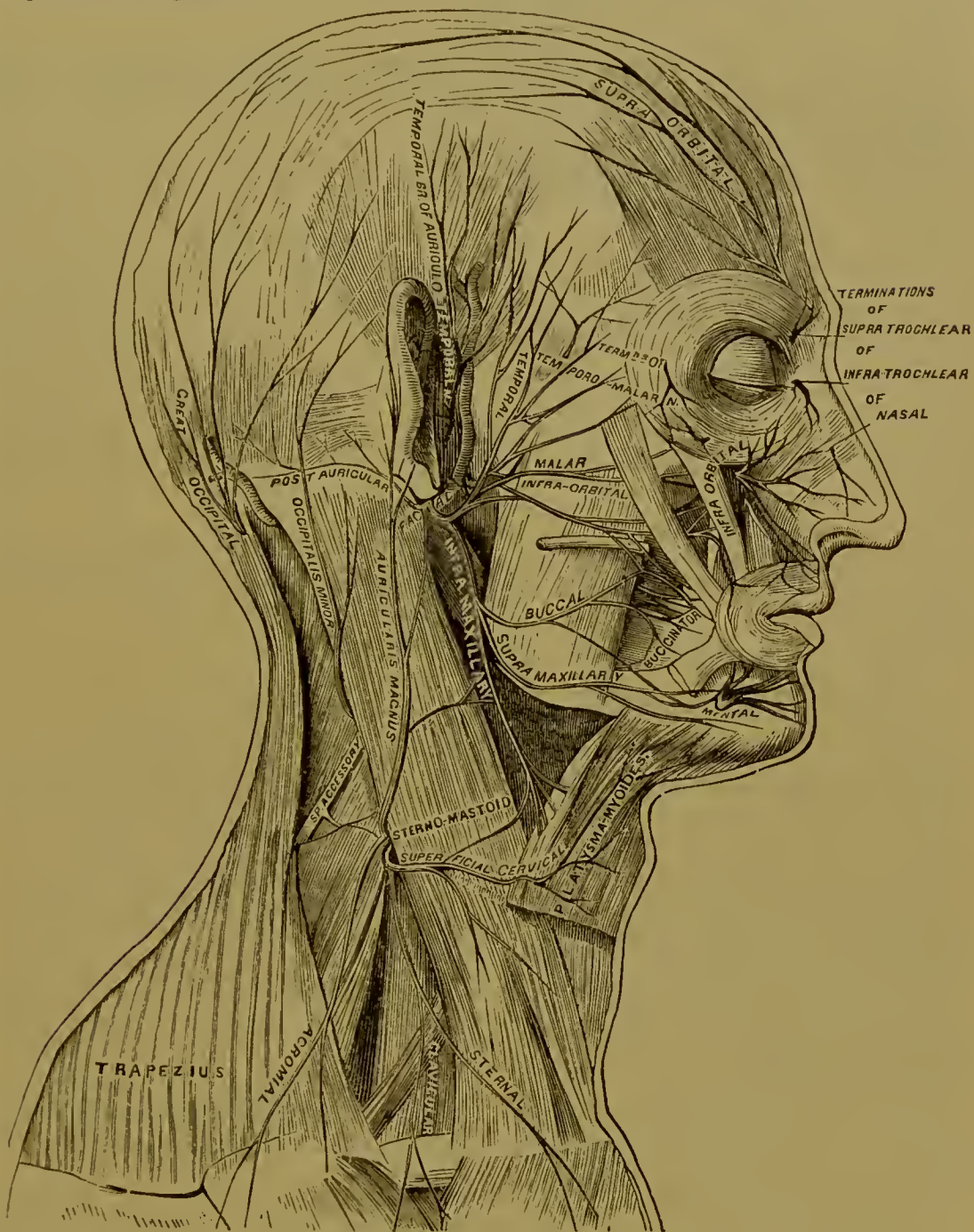


FIG. 35.

The *Posterior Auricular* ascends behind the ear, crosses the mastoid process, where it receives branches from the pneumogastric, and the auricularis magnus; it then divides into two branches, one of which passes to the retrahens aurem, the other to the occipito-frontalis muscle.

The *Stylo-hyoid* is distributed to the stylo-hyoid muscle. It communicates with filaments of the sympathetic sent to the carotid artery.

The *Digastric* is distributed to the posterior belly of the digastric muscle, receiving a communicating branch from the glosso-pharyngeal.

The facial nerve, while deeply imbedded in the substance of the parotid gland, divides into two sets of branches, of which one is superior and the other inferior; these two, by frequent unions, form the *pes anserinus* or *parotidean plexus*, and send branches to the whole of the side of the face.

The upper division, called the temporo-facial, ascends in front of the ear upon the zygoma, accompanies the temporal artery, and its branches, supplying the side of the head, ear, and forehead, and anastomosing with the occipital and supra-orbital nerves; a set of branches pass transversely to the cheek, furnishing the lower eyelid, lips, and side of the nose, and uniting with the infra-orbital nerve.

The inferior or cervico-facial division descends, supplying the lower jaw and upper part of the neck, giving off the following branches:—

1. Buccal.
2. Inferior Maxillary, and
3. Cervical.

The *Buccal*, or superior branches, supply the muscles of the cheek, nose, and upper lip.

The *Inferior Maxillary* nerves are distributed in the muscles of the chin and lower lip, and by means of anastomotic branches communicate with the inferior dental nerve.

The *Cervical* branches form a close connection with the superior cervical nerves, and supply the platysma myoid and the levator labii superioris muscles.

The facial is the motor nerve of the face, and by its means the passions or emotions find their expression in the peculiar action of the muscles to which it is distributed.

In consequence of the numerous communications which this nerve has with other nerves, the name of *Sympatheticus Minor* has been given to it by some anatomists.

Mr. Gray furnishes the following concise statement of these communications :—

In the internal auditory meatus, . . .	With the auditory nerve.
In the aqueductus Fallopii,	With Meckel's ganglion by the large petrosal nerve.
	With the optic ganglion by the smaller petrosal nerve.
	With the sympathetic on the middle meningeal by the external superficial petrosal nerve.
At its exit from the stylo-mastoid foramen,	With the pneumogastric.
	“ “ glosso-pharyngeal.
	“ “ carotid plexus.
	“ “ auricularis magnus.
On the face,	“ “ auriculo-temporal.
	With the three divisions of the fifth.

CHAPTER VII.

SALIVARY GLANDS AND SALIVA.

THE Salivary Glands are six in number, three on each side of the face, named the *Parotid*, *Submaxillary* and *Sublingual*.

These glands are the prime organs in furnishing the salivary fluids to the mouth during the process of mastication.

The *Parotid Gland* (Fig. 36), so called from its situation near the ear, is the largest of the salivary glands. Its form is very irregular ; it fills the space lying between the ramus of the inferior maxilla and mastoid process of the temporal bone, as far back as, and even behind, the styloid process of the same bone. Its extent of surface is from the zygoma above to the angle of the lower jaw below, and from the mastoid process and meatus behind to the masseter muscle in front, overlapping its posterior portion. It weighs between five and eight drams, and is separated from the submaxillary gland by the stylo-maxillary ligament ; but sometimes the two glands are continuous.

This gland is one of the conglomerate order, and consists of numerous small lobes connected together by cellular tissue, each of which may be considered a small gland in miniature, as each is supplied with an artery, vein and excretory duct.

This gland thus formed presents on its external surface a pale, flat and somewhat convex appearance.

It is covered by a dense, strong fascia, extending from the neck, and

attached to the meatus externus of the ear, which sends countless processes into every part of the gland, separating its lobules and conducting the vessels through its substance.

The use of this gland is to secrete or separate from the blood the greater part of the saliva furnished to the mouth. As the parotid is, however, on the outside, and at some little distance from the mouth, it is furnished with a duct to convey its fluid into this cavity; this duct is called the duct of Steno, or the parotid duct. It is formed of



FIG. 36.

the excretory ducts of all the granules composing this gland, which, successively uniting together, at last form one common duct.

The duct of Steno commences at the anterior part of the gland and passes over the masseter muscle, on a line drawn from the lobe of the ear to the middle part of the upper lip; then passes through a quantity of soft adipose matter, and finally enters the mouth by passing through the buccinator muscle and mucous membrane, opposite the second molar of the upper jaw.

The diameter of this duct is about that of a crow-quill, but its orifice is small and contracted, and is concealed by a fold of mucous mem-

brane. It is thick and strong, and is more exposed to injury than the duct of the submaxillary gland.

The arteries supplying the parotid gland are from the external carotid or some of its branches.

The nerves are derived from the carotid plexus of the sympathetic, and from the facial, temporal, and great auricular.

The parotid secretion is a clear, watery, alkaline liquid, which is poured out abundantly during mastication, but in very small quantity when the mouth is at rest. Its secretion may also be excited by mental emotion, as when observing a savory article of food, or by artificial stimuli, as of glass beads or other irritants in the mouth.

The following analysis is taken from Dalton's Physiology :—

COMPOSITION OF HUMAN PAROTID SALIVA.

Water,	983.308
Organic Matter precipitable by alcohol,	7.352
Substance destructible by heat, but not precipitated by alcohol or acids, . .	4.810
Sulpho-cyanide of Sodium,	0.330
Phosphate of Lime,	0.240
Chloride of Potassium,	0.900
Chloride of Sodium and Carbonate of Soda,	3.060
Total,	1000.000

It will be seen that the quantity of organic matter is comparatively large.

Observation has shown that this secretion is unilateral, the saliva flowing only from that side on which mastication is then being conducted, and that the quantity is directly related to the physical character of the food, and not to its chemical constitution, being more or less abundant, according to the dryness of the food.

The *Submaxillary* is the next in size of the salivary glands. It is situated under and along the inferior edge of the body of the lower jaw, and is separated from the parotid by the stylo-maxillary ligament.

The submaxillary gland is partially concealed by the jaw when the head is in the natural position, and weighs about two drams. It is divided into several lobes, and the facial artery occupies a groove on its deeper surface, and also upon its upper border.

It is of oval form, pale color, and, like the parotid, consists in its structure of small lobules, held together by cellular tissue; each having a small excretory duct, which, successively uniting with one another, finally form one common duct. This, the duct of Wharton, passes above the mylo-hyoid muscle, and running forward and inward, enters the mouth below the tip of the tongue at a papilla seen on either side of the frenum linguæ.

The use of this gland is the same as the parotid, to secrete a fluid constituent of the saliva, and its duct is the route by which it is conducted into the mouth. Its arteries are derived from the facial and lingual. The veins correspond. Its nerves are received from the submaxillary ganglion, the inferior dental and sympathetic nerves.

The *Sublingual Glands* are the last in order of the salivary glands, and the smallest in size.

They are situated beneath the anterior and lateral parts of the tongue, are covered by the mucous membrane, and rest upon the mylo-hyoid muscle. Each sublingual gland is oblong in shape and weighs about one dram.

The Sublingual Glands, like the two glands just described, consist of a lobular structure with excretory ducts; which, however, do not unite into one common duct, but enter the cavity of the mouth by many ducts (ducts of Rivinius), from eight to twenty in number, whose openings are through the mucous membrane between the tongue and the inferior cuspid and bicuspid teeth.

These ducts terminate by minute openings behind the orifice of the submaxillary duct along the ridge upon the floor of the mouth. One or more of these ducts enter the submaxillary duct, and one is known by the name of the *duct of Bartholin*.

Their office is the same as the parotid and submaxillary. Their arteries are derived from the sublingual and submental. Their nerves from the gustatory; salivary glands are found in all vertebrate animals except fishes.

The *Saliva*, or oral fluid, consists of the commingled secretion of all these glands. It is a glairy, slightly opalescent, alkaline fluid, consisting of organic and mineral substances held in solution with water. Its composition, according to Bidder and Schmidt, is as follows:—

COMPOSITION OF THE ORAL FLUID.

Water,	995.16
Organic Matter,	1.34
Sulpho-cyanide of Potassium,	0.06
Phosphate of Soda, Lime, and Magnesia, . . . . .	.98
Chlorides of Sodium and Potassium, . . . . .	.84
Mixture of Epithelium,	1.62
	<hr/>
	1000.00

Two kinds of organic matter exist in the saliva; the first, which is found in the submaxillary and sublingual secretions, is called *ptyaline*; to it the saliva owes its viscosity. Alcohol coagulates it, but heat does not, differing, in this respect, from the organic matter derived from the parotid gland, which is coagulated by heat and is not viscid.

Sulpho-cyanogen, the only mineral ingredient that is peculiar to saliva, is detected by a solution of the chloride of iron, with which it strikes a red color characteristic of it.

When saliva has stood for some time it deposits a whitish flocculent sediment, which is found under the microscope to consist of epithelium scales, and other nucleated cells, granular matter, and oil globules. Although saliva possesses the power to change the starchy matter of the food into sugar, yet in view of the facts that this change is interrupted by the gastric juice with which it is so soon to come in contact, and that the quantity secreted is directly related to the physical characteristics of the food, and not to its chemical constitution, not being more abundant during the mastication of starchy food, except it be dry, than of any other aliment, and, furthermore, since the conversion of starch into sugar is otherwise provided for, it may be considered an established fact that its only purpose is to aid mechanically in mastication and deglutition by moistening and lubricating the food. The quantity of saliva secreted daily has been variously estimated by different observers. Mitscherlich thought it about fourteen ounces daily, and Todd and Bowman consider his estimate reliable. Bidder and Schmidt estimated it at about three and a half pounds avoirdupois, and Mr. Dalton at "rather less than three pounds avoirdupois," which is probably very nearly correct.

The *Mucous Glands*.—Besides the glands furnishing the saliva, there is another series of much smaller size, called the *mucous glands*. They are simply the little crypts, follicles, or depressions everywhere found in the mucous membrane of the mouth, and named, according to their situation, the *glandulæ labiales*, *glandulæ buccales*, etc. The lips, cheeks, and palate are also furnished with glands about the size of a small pea, which present the true salivary structure.

The use of these glands is to furnish the mucus of the mouth, which they pour into this cavity by single orifices, opening everywhere on its surface.

The *Buccal Glands* in structure resemble the salivary, and also the labial found beneath the mucous membrane of the lips, though somewhat smaller than the latter. The buccal glands are situated between the buccinator muscle and the mucous membrane.

The *Molar Glands*, three or four in number, are situated between the masseter and buccinator muscles, and their secretion, which is mucous, is conveyed to the mouth by ducts which open near the third molar teeth.

CHAPTER VIII.

THE TONGUE.

THE *Tongue* is a very complicated organ ; it consists of a great variety of parts, and performs a great variety of functions ; it is one of the organs of deglutition ; a glandular organ, to secrete ; a sentient organ, to feel and taste ; and likewise an intellectual organ, to assist in producing speech.



FIG. 37.—"UPPER SURFACE OF THE TONGUE" WITH THE FAUCES AND TONSILS.
1. Papillæ circumvallatæ. 2. Papillæ fungiformes.

The tongue is divided into apex, body, and root ; the apex is the anterior free and sharp portion ; the root, which is thin, is attached to the os hyoides and is posterior ; while the body, which occupies the center, is thick and broad ; it is confined in its situation by the origin of its component muscles and by reflections of the mucous membrane.

The mucous membrane of the tongue covers its free surface everywhere ; it is thinnest on its under surface, where it may be traced along the ducts of the submaxillary and sublingual glands. Passing over the dorsum, it assumes a papillary character, and becomes much thickened.

The papillæ of the tongue are the papillæ circumvallatæ, papillæ fungiformes, and papillæ filiformes.

The papillæ circumvallatæ (maximæ) are situated on each side of the back part of the tongue, meeting at the foramen cæcum so as to form a triangular figure. They number from eight to fifteen.

Each papilla is arranged in the form of an inverted cone, with its apex received into a depression of mucous membrane, and its base exposed on the free surface, and upon it may be seen numerous smaller papillæ.

The papilla fungiformes are scattered irregularly over the surface of the tongue, but are most numerous at its sides and apex. They also are studded on their free surface with smaller papillæ.

The papillæ filiformes are found on the anterior two-thirds of the tongue, and are very minute. They are somewhat conical or filiform in shape, are covered with an unusually dense epithelium, which gives them a whitish appearance, and are filled with secondary papillæ. Small hairs are often found in them.

Structure of the Papillæ.—They consist of papillary loops, through which nerves are abundantly distributed, covered by a homogeneous tissue, upon which is superposed a thick layer of squamous epithelium.

The nerves are large and numerous in the papillæ circumvallatæ; in the papillæ fungiformes and papillæ filiformes they are smaller.

In the mucous membrane are also found follicles or glands. The former are very numerous, especially so between the circumvallate papillæ and the epiglottis, but are found scattered over the entire surface of the tongue. The latter, called mucous or lingual glands, are most abundant on the posterior third of the tongue, but are found also on its tip, sides, and in the neighborhood of the circumvallate papillæ. The ducts open on the free surface of the mucous membrane.

THE MUCOUS MEMBRANE LINING THE MOUTH.

The whole interior cavity of the mouth, palate, pharynx, and lips is covered by mucous membrane, forming folds or duplicatures at different points, called frenæ, or bridles. Beginning at the margin of the lower lip, this membrane can be traced lining its posterior surface, and from thence reflected on the anterior face of the lower jaw, where it forms a fold opposite the symphysis of the chin—the frenum of the lower lip; it is now traced to the alveolar ridge, covering it in front, and passing over its posterior surface, where it enters the mouth. Here it is reflected from the posterior symphysis of the lower jaw to the under surface of the tongue, where it forms a fold or bridle, called the *frenum linguæ*. It now spreads over the tongue, covering its dorsum and sides to the root, from whence it is reflected to the epiglottis, forming another fold; from this point it can be followed, entering the glottis and lining the larynx, trachea, etc.

In the same way, commencing at the upper lip, it is reflected to the upper jaw, and at the upper central incisors, forming a fold, the *frenum* of the upper lip; from this it passes over the alveolar ridge

to the roof of the mouth, which it completely covers, and extends as far back as the posterior edge of the palate bones; from this it is reflected downward over the soft palate, or, more strictly speaking, the soft palate is formed by the duplicature of this membrane at this point, between the folds of which are placed the muscles of the palate already described.

From the palate it is traced upward and continuous with the membrane lining the nares, and downward with the same, lining the pharynx, esophagus, stomach, and intestinal canal.

The mucous membrane, after entering the nostrils and lining the roof, floor, septum nasi, and turbinated bones, enters the maxillary sinus, between the middle and lower spongy bones, and lines the whole of this great and important cavity of the superior maxilla.

Many mucous glands or follicles, already enumerated, are scattered over the whole of this membrane, and furnish the mouth with its mucus.

The mucous membrane of the mouth, which is directly concerned in the development of the teeth, and afterward is in close relation with these organs, is composed of different layers, as follows:—

Epithelium. { Corneous.
Malpighian.

Basement Membrane.

Corium, or Proper Mucous Membrane. { Papillary.
Reticulary.

Submucous Areolar Tissue.

The epithelium, which corresponds to the epidermis of the skin, and is derived from the same source, is composed of two layers, an external and an internal. The external layer, of horny consistence, and known as the corneous layer—*stratum corneum*—is formed of old epithelial cells, which, owing to changes from prismatic or columnar cells during their migration from the internal to the external surface of the membrane, have become thin, devitalized scales, devoid of function. These old epithelial cells are being continually cast off as effete matter, others taking their places, which in turn undergo a similar process of devitalization and exfoliation.

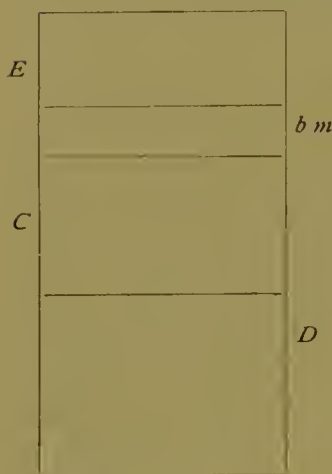


FIG. 38.—DIFFERENT LAYERS OF MUCOUS MEMBRANE.

E. Epithelium. *b m.* Basement membrane. C. Corium. D. Submucous areolar tissue.

The epithelium of the mouth is analogous in form to the skin, and the slight modification is due to its immersion in the oral fluids, which prevents its external

layer from assuming the horn-like or corneous nature of the same layer of the skin. The epithelial cells are united in layers by an intercellular cement-substance, and the superficial layer, which is composed of thin scales or discs, contains nuclei, differing, in this respect, from the corneous layer of the skin, which does not usually contain nuclei.

The internal or Malpighian layer is formed of living epithelial scales or cells, which are of various forms and sizes, and are placed vertically upon the "basement membrane," which separates the epithelium from the corium (proper mucous membrane). The cells of this internal layer are variously designated as the prismatic, columnar, cylindrical, or Malpighian layer, and have large nuclei, but are destitute of a cell-wall. This layer constitutes the perpetual

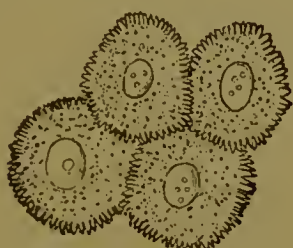


FIG. 39.—CELLS COMPOSING THE STRATUM CORNEUM OR EXTERNAL LAYER OF EPITHELIUM (from Frey).

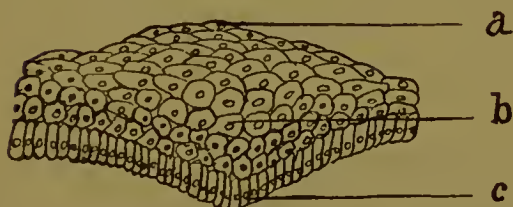


FIG. 41.—*a*. Flat layer of epithelial cells thrown upward into the "burrelet" of Legros and Magitot. *b*. Enlargement and proliferation of cells in cuboidal layers, forcing flat layer upward and columnar layer downward. *c*. Columnar layer of cells directly over position which will be occupied by future jaw.

portion of the enamel organ, which during the development of a tooth is known as the "enamel membrane."

The basement membrane, known as the *membrana præformativa* of Raschow, is situated below the internal or Malpighian layer, and is a homogeneous structure, which in some parts partakes of the character of a membrane, especially where it is of considerable thickness.

Although not usually recognized as a layer of mucous membrane, yet it is interesting from the fact that the dentine bulb or germ and the enamel organ are found on the opposite sides of it, the former below and the latter above it.

The Corium or *mucosa*, which is the proper mucous membrane, is

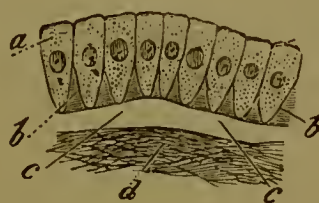


FIG. 40.—INTERNAL OR MALPIGHIAN LAYER OF THE EPITHELIUM.

a. Infant cells, known as prismatic, columnar, or cylinder cells. *b*. Intermediate matter. *d*. Fibrous tissue of the corium.

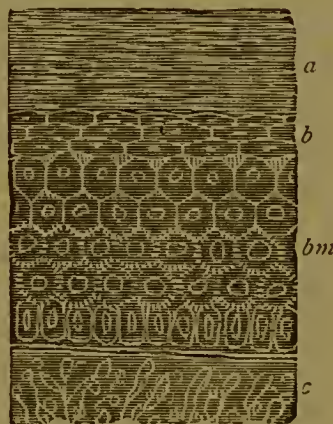


FIG. 42.—*a*. Stratum corneum. *b*. Stratum Malpighii. *bm*. Basement membrane. *c*. Corium.

situated beneath the basement membrane, and is analogous to the derma of the skin. It consists of a fibro-vascular layer of variable thickness, merging into the submucous areolar tissue, and contains, besides the white and yellow fibrous tissue and the vessels, muscular fibre cells (forming what is known in some localities as the *muscularis mucosæ*), nerves and lymphatics.

Mucous glands project from its surface, and with the processes known as villi and papillæ, common to mucous membrane covering the tongue, are analogous to the papillæ of the skin.

THE GUM.

The gum is composed of dense, elastic, fibrous tissue, adhering to the periosteum of the alveolar tissue. It is remarkable for its insensibility and hardness in the healthy state, but exhibits great tenderness upon the slightest injury when diseased. The gum differs in texture from that of the mucous membrane lining the inside of the lips, covering the floor of the mouth and the palate, of which it is a continuation, by being thicker and denser, and of less sensibility. Its hardness is due, in a great measure, to the numerous tendinous fasciculi in its substance, and also to its being closely blended with the dense fibrous fasciculi of the periosteum, which causes it to closely adhere to the bone. These fasciculi of the gum, arising from the periosteum, expand in fan-like form as they approach the epithelial surface. The substance of the gum contains broad-based papillæ, either single or compound, and the epithelium is formed of laminæ of tessellated cells, very much flattened near the surface, but with cylindrical cells composing the Malpighian or deepest layer. The gums are very vascular, being freely supplied with vessels, but with few nerves. A free margin of gum, about half a line in width, surrounds the base of each tooth, and they present a festooned appearance, caused by elongations in the interdental space. The portion of the gum which adheres to the neck of the tooth is of a very fibrous structure. At the necks of the teeth the gum is continuous with the periosteum of the inner surface of the alveoli, being reflected back upon itself, and uniting with the true peridental membrane. The gum of the upper jaw is supplied with vessels from the superior coronary artery, and that of the lower jaw from the submental and sublingual arteries. They derive their nerves from the superior dental branches of the fifth pair.

In the infant state of the gum, the central line of each dental arch presents a white, firm, cartilaginous ridge, which gradually becomes thinner as the teeth advance; and in old age, after the teeth drop

out, the gum again resumes somewhat its former infantile condition, showing "second childhood."

The gum, being endowed with a high degree of vascularity, indicates very correctly; the state of the constitutional health.

THE PERIDONTAL MEMBRANE.

The Peridental Membrane lines the *alveolar cavities* or sockets, of the teeth, covers the roots of each, is attached to the gums at the necks, and to the blood-vessels and nerves where they enter the roots of the teeth at their apices; and, further, Mr. Thomas Bell believed it passes into the cavities of the teeth, forming their lining membrane, and is continuous with or the same as that of the pulp.

Mr. Charles Tomes, in describing this membrane, says: "It is thicker near to the neck of the tooth, where it passes by imperceptible gradations into the gum and periosteum of the alveolar process, and near to the apex of the root. The general direction of the fibres is transverse—that is to say, they run across from the alveolus to the cementum, without break of continuity, as do also many capillary vessels; a mere inspection of the connective-tissue bundles, as seen in a transverse section of a decalcified tooth in its socket, will suffice to demonstrate that there is but a single 'membrane,' and that no such thing as a membrane proper to the root and another proper to the alveolus can be distinguished; and the study of its development alike proves that the soft tissue investing the root and that lining the socket are one and the same thing; that there is but one 'membrane,' namely, the alveolo-dental periosteum. At that part which is nearest to the bone the fibres are grouped together into conspicuous bundles; it is, in fact, much like any ordinary fibrous membrane. On its inner aspect, where it becomes continuous with the cementum, it consists of a fine network of interlacing bands, many of which lose themselves in the surface of the cementum. But although there is a marked difference in histological character between the extreme parts of the membrane, yet the markedly fibrous elements of the outer blend and pass insensibly into the bands of the fine network of the inner part, and there is no break of continuity whatever. At the surface of the cementum it is more richly cellular, and here occur abundantly large, soft, nucleated plasm masses, which are the osteoblasts concerned in making cementum, and which, by their offshoots, communicate with plasm masses imprisoned within the cementum." According to Wedl, the vascular supply of the peridental membrane is derived from the gums, the vessels of the bone, and the vessels destined for the pulp of the tooth, the last being the most important. The nerves supplying this membrane are derived from the dental pulp and

from the nerves of the bone; hence it is apparent that the relationship between the pulp and peridental membrane of the teeth is very intimate.

ANATOMICAL RELATIONS OF THE MOUTH.

The mouth has many interesting anatomical relations with the rest of the body, a few of which it may be well to mention.

By means of its lining mucous membrane it is connected, through continuity of structure, with the pharynx, œsophagus, stomach, and the whole of the intestinal canal, etc.

Disease still further establishes this structural relation. Inflammation, ulceration, or any other pathological change in the stomach or intestines, is felt and reported on the tongue, gums, and other parts of the mouth, showing the sympathy and close relationship of these several parts.

The mouth is also connected by the same mucous membrane with the organs of respiration, by being continued down into the larynx, trachea, and bronchi.

Widespread sympathies are established between the mouth and other parts by means of the numerous nerves which animate the parts constituting its boundaries and lying in its cavity, as the sympathetic, the seventh, the glosso-pharyngeal, the par vagum, the hypoglossal, and upper cervical.

Simple irritation from teething has thrown children into convulsions, and in adults toothache often creates extreme irritability of the whole nervous system. But it is not necessary to dwell here on the sympathies of the mouth in disease with other parts of the body, as the author will have occasion to do this in other parts of this work.

It will be well, however, to mention in this place that there is a general anatomical relation of the mouth with the rest of the body, by means of the blood-vessels and areolar tissue.

PHYSIOLOGICAL RELATIONS OF THE MOUTH.

It has been shown that the mouth consists of a great variety of parts, and, also, that it has an equally great diversity of functions.

The functions of the mouth have been stated to be those of prehension, mastication, insalivation, and deglutition.

These functions, it has been seen, are all closely related to one another and mutually dependent; and how beautiful is the harmony of action as well as its regular and orderly succession! We see, in the first place, the prehensile instruments laying hold of and introducing the food into the mouth; then the organs of mastication, the teeth and upper and lower jaw bones, put into operation by the temporal, masseter, and pterygoid muscles, grind it down into minute portions;

these, at the same time, are formed into a bolus by being mixed with the salivary fluids furnished by the parotid, submaxillary, and sublingual glands; then the mass is taken by the organs of deglutition, namely, the tongue, palate, and pharynx, and passed into the œsophagus, to be thence conducted into the stomach, thus demonstrating the harmony existing among the several functions belonging to the mouth.

But the functional relation of the mouth is no less extensive than its structural relation; the one is commensurate with the other; and as the structure of the mouth has been shown to be continuous with that of other parts of the body, so we find that the functions of the mouth exert an influence upon, and are themselves influenced by, many great and leading functions of the body. The connection between mastication and insalivation, for example, with stomachal digestion, or chymification, is especially obvious.

Again, the mouth is intimately related with the intellectual functions, as, for instance, that of speech. Who does not know that when any of the teeth are wanting, the palate cleft, or there is a hare-lip, how much the speech is impaired? And so with all the other functions of the body; the relations between them and the mouth, and the mutual dependence of each on the other, is equally demonstrable.

CHAPTER IX.

THE TEETH.

The teeth in the human mouth are the prime organs of mastication, are the hardest portion of the body, and are implanted in the alveolar cavities of both the upper and lower jaw.

A tooth is composed of four distinct structures: 1. The *pulp*, occupying the chamber in the crown and the canal extending through the root; 2. The *dentine*, which constitutes the principal part of the organ; 3. The *enamel*, which forms the covering and protection of the crown; 4. The *cementum*, or *crusta petrosa*, which covers the root. (See Fig. 43.)

Two sets of teeth are developed in the mouth, one of first dentition and one of second dentition.

The teeth of first dentition, termed the milk, temporary, or deciduous teeth, are designed merely to supply the wants of childhood, and are replaced with a larger, stronger, and more numerous set. The teeth

of second dentition are termed the permanent or adult teeth, and are intended to continue through life.

The anatomical divisions of a tooth are : 1. The crown, or exposed part, situated above the gum ; 2. The root, occupying the alveolar cavity, or socket ; 3. The neck, which is the constricted portion between the crown and root.

THE TEMPORARY TEETH.

The temporary teeth (Figs. 44 and 45) are divided into three classes : first, the incisors ; second, the cuspids, or canine teeth ; third, the molars, which are succeeded by the bicuspid, or premolars, which are not represented in the temporary set.

The temporary teeth are twenty in number, ten in each jaw, namely : four incisors, two cuspids, and four molars.

The incisors of the upper jaw are implanted in the pre-maxillary bones, which early in life unite with the maxillaries.

The pulp-cavity in a temporary tooth is also larger in proportion to the size of the organ

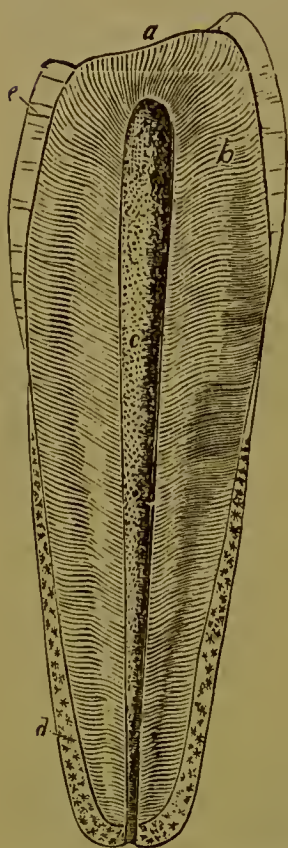


FIG. 43.—*a*. The coronal surface divested of enamel. *b*. The dentine. *c*. The pulp cavity. *d*. The cementum, or crusta petrosa. *e*. The enamel.

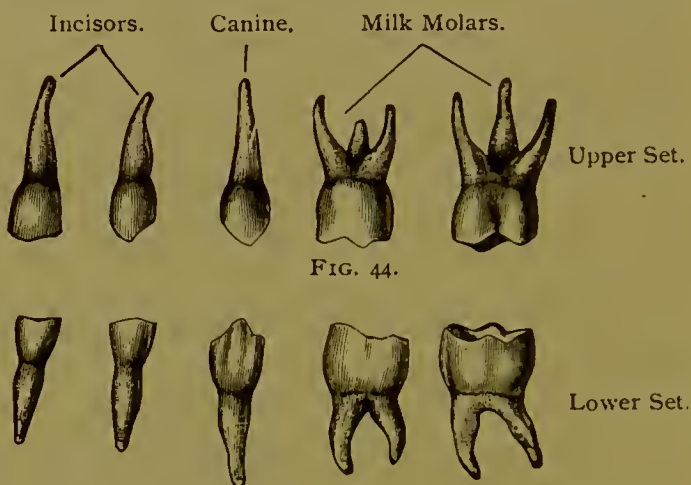


FIG. 44.



FIG. 45.

than in a permanent tooth. The pulp-cavities of the central and lateral incisors are of the same general shape, like that of an elongated tube, while those of the canines and molars correspond with the form of these teeth.

THE PERMANENT TEETH.

There are thirty-two teeth in the permanent set, sixteen to each jaw—being an increase of twelve over the temporary, designated as follows : incisors, four ; cuspids, two ; bicuspid, or premolars, four ;

molars, six—in each jaw. The surfaces of the teeth covered by the lips are called “labial;” by the cheeks, “buccal;” toward the roof of the mouth on the upper jaw, “palatal;” toward the tongue on the lower jaw, “lingual.” The name “proximate” is given to the surfaces next to each other; the surfaces looking toward the center are called “mesial;” and those looking from the center, “distal.”

DESCRIPTION OF TEETH BELONGING TO EACH CLASS.

Each tooth, as has already been remarked, has a body or crown, a neck, and a root or fang. In describing these several parts, we shall begin with

The *Incisors* (four to each jaw, and so-called from the Latin word *incidere*, to cut, on account of their sharp, cutting edges (Figs. 46

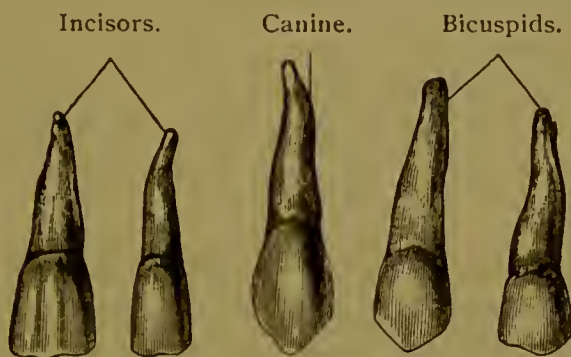


FIG. 46.—UPPER INCISORS, CANINES, AND BICUSPIDS.



FIG. 47.—LOWER INCISORS, CANINES, AND BICUSPIDS.

and 47). They occupy the anterior central part of each maxillary arch. The body of each is wedge-shaped—the anterior or labial surface is convex and smooth; the posterior or palatal is concave, and presents a tubercle near the neck; the palatal or labial surfaces come together and form a cutting edge. In a front view, the edge is generally the widest part; it diminishes toward the neck, and continues narrowing to the extremity of the root.

The crown of an incisor has four surfaces: two *proximate*, or *mesial* and *distal*, the mesial toward the median line and the distal away from the median line, one *labial*, and one *palatal*, or *lingual*—the term *palatal* being applied to the inner surface of an upper, and *lingual* to

the inner surface of a lower, incisor. It also has four angles: namely, a *right* and a *left labio-proximate* and a *right* and *left palato-proximate*, or *lingua-proximate*.

The two large incisors which are situated one on each side of the median line are termed the central incisors; the other two, the lateral incisors, or laterals, because they occupy a position on either side of the centrals. The crowns of the upper central incisors are about four lines in breadth, and the laterals three. In the lower jaw, the crowns of the central incisors are only about two lines and a half in width, while the laterals are usually a little wider. But the width of the crowns of all the incisors varies in different individuals.

The length of a superior central incisor is usually about one inch, and that of a lateral is half of a line less. In the lower jaw the central incisors are only about ten lines in length; the laterals are about one line and a half longer.

The length of the crown of an incisor is exceedingly variable. That of an upper central varies from four and a half to six lines; and there is the same want of uniformity in this respect with the crowns of all the incisors.

The superior central incisors are somewhat more prominent than the lateral incisors, owing to the curve of the alveolar process. The newly-erupted incisors have three points or cusps on their cutting edges, which soon disappear through wear, leaving such edges smooth and uniform. The labial aspect of the crown of a superior central incisor is convex, and the vertical diameter is greater than the transverse. Of the lateral surfaces, the mesial is generally flat, while the distal is more rounded. The lateral incisors are more slender in shape and smaller than the central incisors, but have the same general form, with somewhat more convexity of the labial surface.

The roots are all single, of a conical form, flattened laterally, and slightly furrowed longitudinally. Those of the lateral incisors (Figs. 46 and 47) are more flattened laterally than the roots of the centrals, slightly longer, and more gradually tapering toward the apex. The pulp-cavities of all the incisors have the same shape—like that of an elongated tube. The enamel is thicker before than behind, and thinnest at the sides.

The function of this class of teeth, as their name imports, is to cut the food, and for the performance of this office they are admirably fitted by their shape. As age advances, their edges often become blunted; but the rapidity with which they are worn away depends altogether upon the manner in which those of the upper and lower jaw come together.

THE CUSPIDATI, OR CUSPIDS.

The *Cuspidati*, *Canini*, or *Cuspids*, so called from the Latin word *cuspis*, ‘‘a point,’’ because they terminate in a point, are commonly known by the name of canines (Figs. 46 and 47). They are situated next to the incisors, and occupy the space between the lateral incisor and first bicuspid, two to each jaw, one on either side. They somewhat resemble the upper central incisors with their angles rounded. Their crowns are conical, very convex externally, and their palatal surface more uneven, and they have a larger tubercle than the incisors. The crown ends in a blunt point, and the cutting edge slopes away on each side. The slope toward the bicuspid is the longer, and causes the crown to be asymmetrical. The lingual surface presents a median and two lateral ridges; they converge toward the well-marked cingulum, which is often produced into a distinct cusp (Fig. 48).

The lower canines have not such pronounced features as the upper; the point is blunter, and the median ridge is absent from the lingual surface. They are stronger and generally more durable teeth than the incisors, and their roots form a vertical ridge on the external surface of the alveolar process. Their roots are also larger, and of all the teeth the longest; like the incisors, they are also single, but have a groove extending from the neck to the extremity, showing a step toward the formation of two roots. A cuspid, like an incisor, has four surfaces and four angles, designated by the names already given—labial, palatal or lingual, mesial, distal.

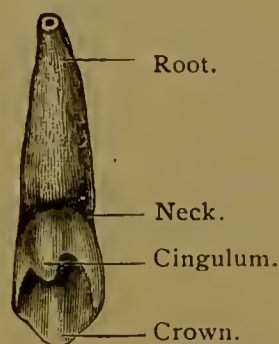


FIG. 48.

The breadth of the crown of an upper cuspid is about four lines, that of a lower is about three and a half; but, as in the case of the incisors, the width of the crowns of these teeth is variable. The length of a cuspid is greater than that of any other tooth in the dental series—it being about thirteen lines. The breadth of the neck of one of these teeth is about one-third greater in front than behind, and from before backward it measures about four lines.

The upper cuspids, with no good reason, are sometimes called eye teeth; the lower are termed stomach teeth.

The inferior cuspids have a shorter root than the superior cuspids, and the median cusp is not so pointed.

These teeth are for tearing the food, and in some of the carnivorous animals, where they are very large, they not only rend but also hold their prey.

The incisors and cuspids together are termed the *oral* teeth.

THE BICUSPIDS.

The *Bicuspid*s, so called from the Latin words *bis*, "twice," and *cuspid*s, "a point" (Figs. 46 and 47), four to each jaw and two on either side, are next in order to the cuspids. They have two distinct prominences or cusps on their grinding surfaces, one external and the other internal, and separated by a deep depression or notch. In the superior bicuspid the external cusp is somewhat larger than the internal cusp, while in the inferior bicuspid the internal cusp is larger than the external, and the root is more cylindrical in form. They are also named premolars or the small molars, but are more commonly designated as the first and second bicuspid. They are thicker from their buccal to their palatine surface than either of the incisors, and are flatter on their sides. The buccal surfaces are very convex, and the crowns of the second bicuspid are generally somewhat larger than those of the first bicuspid, and more of a square form.

A bicuspid has five surfaces: namely, two *proximate* — *mesial* and *distal*; one *buccal*; one *palatal* or *lingual* surface, as the tooth may be in the upper and lower jaw, and one *grinding* surface. It has four angles; one *anterior* or *mesio-* and one *posterior* or *disto-palato-proximate* and one *anterior* or *mesio-* and one *posterior*, or *disto-bucco-proximate* angle.

The size of these teeth, like that of the incisors and cuspids, is variable. The buccal surface of the crown of a superior bicuspid of ordinary size at its broadest part is about three lines in breadth, while the anterior and posterior proximal surfaces are about four lines. The palatal is quite as wide as the buccal surface. All the diameters of the crown of a lower bicuspid are usually a little less than those of an upper. The entire length of a bicuspid is ordinarily about eleven lines.

The superior bicuspid has generally two roots, but sometimes a single root, which is often deeply grooved, while the inferior bicuspid has but one root. The deeply-grooved root is indicative of two pulp-cavities, which may unite at the central portion of the root and form a narrow transverse fissure at the neck of the tooth. Of the two roots of the superior bicuspid, the inner or palatal is smaller than the outer or buccal, each root having an opening for the vessels and nerves to enter.

THE MOLARS.

The *Molars*, so called from the Latin word *molaris*, "grinding," and designated as first, second, and third molars (Figs. 49 and 50), occupy the posterior part of the alveolar arch, and are six in each jaw, three on either side. The first, owing to the period of their eruption,

are called the sixth-year molars, and the second, for the same reason, are called the twelfth-year molars, while the third are called the *dentes sapientiæ*, or wisdom teeth, from the Latin word *dens*, "a tooth," and *sapientia*, "wisdom," being erupted at a period when maturity is reached. The molars are distinguished by their greater size—the first and second being the largest; the grinding surfaces have the enamel thicker, and are surmounted by four or five tubercles or cusps, with as many corresponding depressions arranged in such a manner that the tubercles of the upper jaw are adapted to the depressions of the lower, and *vice versa*.

A molar, like a bicuspid, has also five surfaces and five angles, designated by the names already given to similar surfaces on the bicuspids.

The upper molars have three roots, sometimes four, and as many as

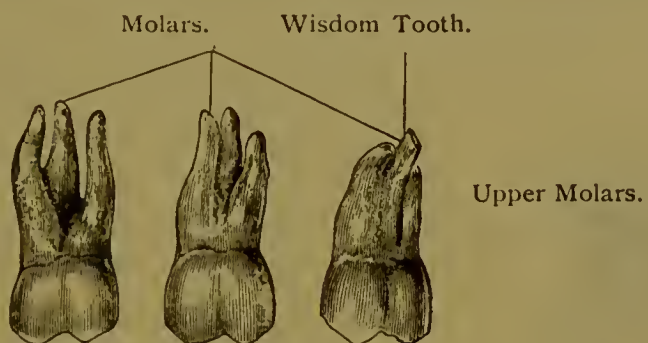


FIG. 49.

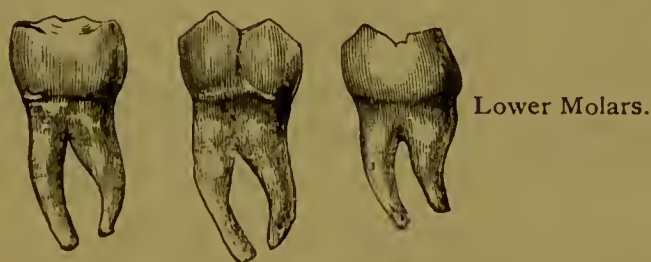


FIG. 50.

five are occasionally seen; of these roots two are situated externally, almost parallel with each other, and perpendicular; the third root forms an acute angle, and looks toward the roof of the mouth. The former are called the *buccal* roots, and the latter the *palatal*. The roots of the first two superior molars correspond with the floor of the maxillary sinus, and sometimes protrude into this cavity, their divergence securing them more firmly in their sockets. The lower molars have but two roots—the one anterior, the other posterior; they are nearly vertical, parallel with each other, and much flattened laterally.

The last molar, or wisdom tooth, is both shorter and smaller than the others; the roots of the upper wisdom tooth are, occasionally,

united so as to form but one ; while the last molar of the lower jaw is generally single and of a conical form.

The roots of the molar teeth, both of the upper and lower jaw, after diverging, sometimes approach each other (converge), embracing the intervening bony partition in such a manner as to constitute an obstacle to their extraction.

The bucco-palatal diameter of the crown of an upper molar is usually a little less than the antero-posterior. In the lower jaw, the bucco-lingual and antero-posterior diameters are generally about the same.

The crown of the first molar is generally larger than the second, and the second larger than the third or wisdom tooth ; and the crown of the last-named tooth is always smaller in the upper than in the lower jaw.

The pulp-cavities correspond to the external form of the roots, and at the necks of these teeth they unite into a common cavity called the pulp-chamber, which often ends in cornua corresponding to the cusps (Fig. 51).

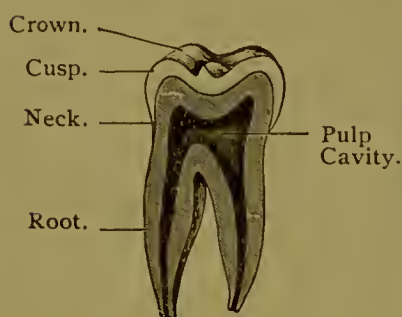


FIG. 51.

The length of a molar tooth varies from eight to twelve and a half or thirteen lines.

The molars and bicuspid together constitute what are termed the buccal teeth.

The use of the molars, as their name signifies, is to triturate or grind the food during mastication, and for this purpose they are admirably adapted by their mechanical arrangement.

ATTACHMENT OF THE TEETH.

The manner in which the teeth are confined in their sockets is by a union called *gomphosis*, from the resemblance of this kind of articulation to the way in which a nail is received into a board. The teeth having but one root, and those with two perpendicular roots, depend greatly, for the strength of their articulation, on their nice adaptation to their sockets.

Those having three or four roots have their firmness much increased by their divergence ; also teeth with two roots which converge.

But there are other bonds of union ; by the periosteum lining the alveolar cavities, and investing the roots of the teeth ; also by the blood-vessels entering the apices of the roots ; and finally, by the gums, which will be noticed in another place.

DIFFERENCES BETWEEN THE TEMPORARY AND PERMANENT TEETH.

The temporary and permanent teeth differ in several respects, and on this point I will give Mr. Bell's observations :—

“The temporary teeth are, generally speaking, much smaller than the permanent; of a less firm and solid texture, and their characteristic forms and prominences much less strongly marked. The incisors and cuspids of the lower jaw are of the same general form as in the adult, though much smaller; the edges are more rounded, and they are not much more than half the length of the latter. The molars of the child, on the contrary, are considerably larger than the bicuspid which succeed them, and resemble very nearly the permanent molars.

“The roots of the tooth in the molars of the child are similar in number to those of the adult molars, but they are flatter and thinner in proportion, more hollowed on their inner surfaces, and diverge from the neck at a more abrupt angle, forming a sort of arch.”

In the temporary teeth the union of the enamel and cementum is distinctly marked by a well-defined ridge of enamel at the base of the crown, which forms a constricted neck; whereas in the permanent teeth the union of the enamel and cementum at the base of the crown is very indistinct.

RELATIONS OF THE TEETH OF THE UPPER TO THOSE OF THE LOWER JAW, WHEN THE MOUTH IS CLOSED (ARTICULATION).

The crowns of the teeth of the upper jaw are generally arranged in the form of a semi-ellipse, and describe a rather larger arch than those of the lower. The upper incisors and cuspids naturally shut over and in front of the lower; but sometimes they fall plumb upon them, and at other times, though unnaturally, they come on the inside. In the curve of the arch, the cuspids stand a little prominent, giving a fullness to the angles of the mouth. The external tubercles or cusps of the superior bicuspid and molars generally strike on the outside of those of the corresponding inferior teeth. By this beautiful adaptation of the tubercles of the teeth of one jaw to the depressions of those of the other, every part of the grinding surface of these organs is brought into immediate contact in the act of mastication; which operation of the teeth, in consequence, is rendered more perfect than it would be if the organs came together in any other manner.

The incisors and cuspids of the upper jaw are broader than the corresponding teeth in the lower; in consequence of this difference in the lateral diameter of the teeth of the two jaws, the central incisors of the upper cover the centrals and about half of the laterals in the lower, while the superior laterals cover the remaining half of the infe-

rior and the anterior half of the adjoining cuspids. Continuing this peculiar relationship, the upper cuspids close over the remaining half of the lower and the anterior half of the first inferior bicuspids, while the first superior bicuspids cover the remaining half of the first inferior and the anterior half of the second. In like manner, the second bicuspids of the upper jaw close over the posterior half of the second and the anterior third of the first molars in the lower. The first superior molars cover the remaining two-thirds of the first inferior and the anterior third of the second, while the two-thirds of this last and anterior



FIG. 52.

third of the lower *dentes sapientiæ* are covered by the second upper molars. The *dentes sapientiæ* of the superior maxilla, being usually about one-third less in their antero-posterior diameter, cover the remaining two-thirds of the corresponding teeth in the lower jaw. (See Fig. 52.)

Thus, from this arrangement of the teeth, it will be seen that when the mouth is closed each tooth is opposed to two; and hence, in biting hard substances and in mastication, by extending this mutual aid, a power of resistance is given to these organs which they would not

otherwise possess. Moreover, as Mr. Tomes very justly observes, if one, or even two adjoining teeth should be lost, the corresponding teeth in the other jaw would, to some extent, still act against the contiguous organs, and thus, in some degree, counteract a process, which nature sometimes sets up for the expulsion of such teeth as have lost their antagonists.

CHAPTER X.

MALFORMED TEETH.

Peculiarities in the Formation and Growth of the Teeth.—In the development and growth of the various parts of the body, curious and interesting anomalies are sometimes observed; but in no portion of it are they more frequent in their occurrence or diversified in their char-



FIG. 53.



FIG. 54.

FIG. 53 shows the front view of the lateral incisor and canine from the left side of the under jaw, united throughout their entire length, but with the line of junction well marked. The age at which they were removed was seven years. The corresponding teeth on the opposite side of the jaw were similarly united.

FIG. 54 shows the representation of the lateral incisor and canine from the left side of the lower jaw of a patient aged nine years. In this example the line of junction is less distinctly marked than in the preceding illustration, and is altogether wanting near the base of the enamel.

acter than in the teeth. But aberrations in the formation and growth of these organs are, for the most part, confined to the teeth of second dentition.

Although the deciduous teeth are much more exempt from deviation in form, size, and number than the permanent teeth, yet they are not altogether free from such irregularities. One form of irregularity of these teeth may consist in a greater number than twenty; while in other cases there may be a numerical deficiency. Deciduous teeth, especially the molars, are occasionally met with having more than the normal number of roots. A more common form of irregularity is the union of two, or sometimes even three, deciduous teeth, generally incisors, or an incisor and a canine, either by a union in the cementum, or in the dentine and enamel (Figs. 53 and 54). When the union is in the cementum, the roots only are united, but where it

is in the dentine and enamel there is a fusion of both the crowns and the roots, and one pulp common to the two teeth (geminous).

Fig. 55¹ represents two specimens of triple fusion of the deciduous right superior lateral incisor and cuspid, with a supernumerary tooth between the two, taken from the mouth of a boy three years of age. Fig. 55² represents another specimen of triple fusion of deciduous teeth from the mouth of a little girl, which occupied the same position as that represented by Fig. 55¹, and was composed of the same teeth. Both of these specimens were extracted by Dr. Isaac Douglass.

MALFORMED PERMANENT TEETH.—Irregularity in the forms of permanent teeth is much more common than is the case with deciduous teeth; some of the former differing so much in size, either above or below what is normal, as to occasion disfigurement; in the same mouth very large teeth may be associated with others extremely small, or the malformation may be confined to a single tooth of the set. But examples of this kind are not very frequent; for where there is an

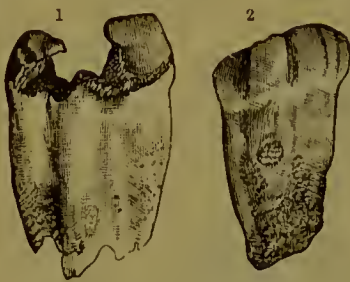


FIG. 55.



FIG. 56.



FIG. 57.

increase or diminution in the size of the teeth of one class, there is generally a corresponding change in that of the other.

Aberrations of this character are probably dependent upon some diathesis of the general system, whereby the teeth, during the earlier stages of their formation, are supplied with an excessive or diminished quantity of nutriment. Again, the malformation may be confined to the root, while the crown of the tooth is of the normal size.

A superior central incisor may have a root which is abnormally small, while the crown is of the usual size.

Another malformation consists in an excess of the normal number of roots, the superior molars sometimes having four or six slender roots, and the inferior molars three and four, the inferior canines two, and the superior bicuspid three roots. (Figs. 56, 57.) The variations in form of the permanent teeth are beyond enumeration; in some cases teeth with single roots are bent at different angles. The crowns of the teeth, also, frequently present deviations from the natural shape equally striking and remarkable.

Figs. 58, 59, and 60 represent molar and incisor teeth with malformed roots.

Teeth with flexed roots are also met with. Figs. 61 and 62 represent superior central incisors with single and double flexions of the roots.

Mr. Fox gives a drawing of a tooth very much resembling the letter S. The author has also met with several examples of teeth similarly deformed, and from like causes.

Some very remarkable deviations have been known to take place in the growth of the teeth. The most singular case on record is that related by Albinus. "Two teeth," says he, "between the nose and the orbits of the eye, one on the right side and the other on the left, were inclosed in the roots of those processes that extend from the maxillary



FIG. 58.

FIG. 59.



FIG. 60.



FIG. 61.



FIG. 62.

bones to the eminence of the nose. They were large, remarkably thick, and so very like the canines that they seemed to be these teeth, which had not before appeared ; but the canines themselves were also present, more than usually small and short, and placed in their proper sockets. The former, therefore, appear to have been new canines, which had not penetrated their sockets, because they were situated where these same teeth are usually observed to be in children. But what is still more remarkable, their points were directed toward the eyes, as if they were the new eye teeth inverted. And they were also so formed that they were, contrary to what usually happens, convex on the posterior and concave on the anterior." A case of a somewhat similar character is mentioned by Mr. John Hunter.

The following case is in the words of Mr. G. Wait: "While I was

prosecuting my anatomical studies, I was struck with the appearance of a cuspid of the upper jaw ; it was short, and appeared as if the body of the tooth was in the jaw, and that it was the tip of the root that presented itself. Upon further examination I found this verified, and after the cranium and lower jaw were properly macerated and cleansed, I found one of the lower bicuspid in the same position."

The following is one of the several cases of deviation in the growth of the teeth that have come under the author's observation: In 1840, he was requested to extract a tooth for a lady of Baltimore under the following circumstances. She had, for a time, experienced a great deal of pain in her upper jaw, and supposed it to originate from the second molar of the right side, but which was perfectly sound. Meanwhile her general health became impaired, and her attending physician, thinking that the local irritation might have contributed to her debility, advised the extraction of the tooth. On removing it, the cause of the pain at once became apparent. The dens sapientiæ, which had not hitherto appeared, was discovered with its roots extending back to the utmost verge of the angle of the jaw, while its grinding surface had been in contact with the posterior surface of the crown and neck of the tooth just extracted. On the removal of the wisdom tooth the pain ceased.

About the middle of December, 1849, a youth aged sixteen applied to the author to extract a right superior bicuspid, which, he said, was ulcerated at the root. On examining his mouth, he discovered only one bicuspid, but above and between the root of this and that of the first molar, he observed a small fistulous opening. On introducing a small probe, it immediately came in contact with the crown of a tooth looking toward the malar process of the superior maxillary, which, on extraction, proved to be the second bicuspid.

The author has in his possession several molar and bicuspid teeth which have small nodes upon their necks, covered with enamel; and there are jaws in the Museums of the Baltimore Dental Colleges which have a number of teeth presenting this anomaly.

The author has two teeth in his possession of most singular shape, presented to him by his brother, the late Dr. John Harris. They were extracted in July, 1822, from the right side of the upper jaw of a young gentleman, nineteen years of age, by the name of Crawford. They occupied the place of the first and second bicuspid and their crowns are almost wholly imbedded in lamellated dentine, that should have constituted their roots, but which are entirely wanting. Judging from their appearance, one would be inclined to suppose that, their sacs failing to contract, they remained stationary in their sockets, and as the base of the pulps elongated, they came in contact with the

bottom of the alveoli, and were caused to bulge out and to be reflected upon their crowns, to the enamel of which, nearly to their grinding surfaces, they are perfectly united. For some time previously to the extraction of these teeth, they had been productive of considerable irritation and pain in the gums and jaw, and it was for the relief of the suffering which their presence induced that they were removed.

Since the above was written, the author has seen a still more remarkable deviation in the growth of a tooth. It is in the upper jaw of an adult skull in which the natural teeth are all well formed and regularly arranged in the alveolar border, but between the extremities of the roots of the superior central incisors, in the substance of the jaw, there is a supernumerary tooth the crown of which looks upward toward the crest of the nasal plates of the two bones. The whole tooth is about one inch in length, and the apex of the crown is nearly on a level with the floor of the nasal cavities. There is also in the Dental Museum of the University of Maryland a central incisor of the upper jaw, with the root bent upon, and in contact with, the labial surface of the crown (Fig. 63).



FIG. 63.

United Teeth.—Inclosed as each tooth is in a distinct sac, and separated on either side by a bony partition from the adjoining teeth, until after the completion of the formation of the enamel, it may be difficult to conceive how osseous union could take place between two of these organs, but so many examples of such union are met with, that there is no longer any question concerning its possibility.

Two or more teeth, generally the molars, may be permanently joined together by a union in the cementum of their roots, occasioned by diseased action, such as exostosis, taking place after the complete development of the teeth. The term “osseous union” has been applied to such cases.

Fig. 64 represents united second and third molars, the one figure presenting the buccal aspect, and the other the palatal.

Fig. 65 also represents the osseous union of superior second and third molars.

Many years ago we had an opportunity of seeing two interesting cases. One consisted in the union of the crowns of the central incisors of the upper jaw, the palatine surface of which presented the appearance of one broad tooth, while anteriorly they had the semblance of two teeth; the other case consisted in the union of the right central and lateral incisors of the lower jaw.

A professional friend informed the author, in a conversation some years since, that he had met with a case of osseous union between a

second bicuspid and the first molar of the lower jaw, which was so palpable that there could have been no doubt of its existence.

Cases of this nature are not very common, and a connection of the roots of two teeth, by an intervening portion of the alveolus, is very easily mistaken for osseous union of the roots themselves. A few years since, in extracting a second molar of the upper jaw, the author brought the dens sapientiæ along with it. At first he thought there was osseous union of the roots, but upon close examination found a very thin portion of the alveolar wall between, to which their roots were firmly attached. Such a case as this would, in many instances, be set down as an example of osseous union.

An osseous union of the teeth is, fortunately, of rare occurrence; if it were otherwise, it would be productive of many accidents in the extraction of teeth. Apart from this consideration, it can be of but little importance either to the practitioner or to the physiologist.



FIG. 64.



FIG. 65.

Since the publication of the first edition of this work, a number of cases of osseous union of the teeth have fallen under the observation of the author. Among them are a number of examples of osseous union of the temporary teeth.

Geminous or Fused Teeth.—When two teeth are united by a union in the enamel and dentine throughout the entire length of their crowns and roots, they are termed “geminous” or “fused” teeth, as the malformation is occasioned by a fusion of their pulp, from close proximity and pressure, one pulp being common to the two teeth. The two central incisors and the lateral incisors and canines are more commonly joined together in this manner than any of the other teeth. Fig. 66 represents geminous central and lateral incisors, showing the labial and palatal aspects, these specimens being in the Dental Museum of the University of Maryland.

Other cases occur where the union or fusion is confined to the crowns of the teeth, the roots being separate.

Fig. 67 represents two geminous central incisors, the crowns of which are united while the roots are separate.

Supernumerary Teeth.—The development of supernumerary teeth is usually confined to the anterior part of the mouth, and more frequently to the upper than to the lower jaw. They sometimes, however, appear as far back as the dentes sapientiæ, and Hudson says he has seen them behind these teeth. We have now in our anatomical collection two supernumerary teeth that were extracted, one from behind and the other at the side of one of the upper wisdom teeth.*

The crowns of supernumerary teeth which appear in the anterior part of the mouth are usually of a conical shape, and for the most part situated between the central incisors; they usually have short, knotty roots; sometimes, however, they bear so strong a resemblance to the other teeth that it is difficult to distinguish the one from the other. We once saw two lateral incisors in the lower jaw, both of



FIG. 66.

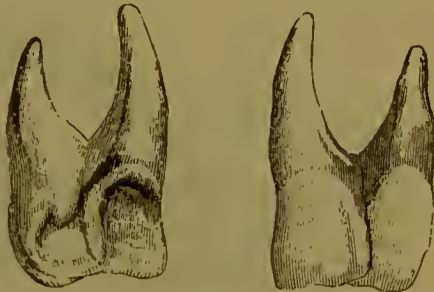


FIG. 67.

which were so well arranged and perfectly formed that it was impossible to determine which of the two ought to be considered as the supernumerary. Mr. Bell mentions a case in which there were five lower incisors, all of which were well formed and regularly arranged. Such teeth, however, are more properly known as “supplemental.”

Supernumerary cuspids rarely if ever occur, but supernumerary bicuspid are occasionally met with. Delabarre says he has seen them; and we have met with three examples of the sort; in each of these instances the teeth were very small, not being more than one-fourth as large as the natural bicuspid, with oval crowns, and placed partly on the outside of the circle and partly between the bicuspid. We extracted one of them, and have it still in our possession. Its root is short, round, and nearly as thick at its extremity as it is at the neck of the tooth.

The supernumerary teeth that appear further back than the bicuspid, though much smaller, bear a strong resemblance to the dentes sapientiæ.

* These teeth were removed by Dr. Chewing, dentist, of Fredericksburg, Va.

Supernumerary teeth, although generally imperfect in their formation, are less liable than other teeth to decay. This may be attributable to the fact that they are harder, and, consequently, not so susceptible to the action of the causes that produce the disease.

Although the occurrence of supernumerary teeth rarely disturbs the arrangement of the others, their presence is sometimes productive of the worst form of irregularity (Fig. 68 represents a case of this kind); and even when they do not have this effect, they impair the beauty of the mouth, and, for this reason, should be extracted as soon as their crowns have completely emerged from the gums.

To the practitioner of dental surgery, the occurrence of supernumerary teeth is interesting only in so far as it affects the beauty of the mouth and the relationship which the teeth of the upper jaw sustain to those of the lower; but to the physiologist it involves the question, what determines their development? In propounding this interroga-



FIG. 68.

tory, however, it is not our intention to enter upon its discussion in this place. (See "Origin of Permanent Teeth.")

Supplemental Teeth.—The term supplemental is employed to designate teeth which resemble in shape and size those of the regular series, as a third lateral incisor or canine, or a fifth bicuspid, in either the upper or lower jaw, the additional teeth being perfectly normal in form. Such teeth are extremely rare, but we have met with several examples in which supplemental teeth so closely resembled the natural incisors that no difference could be discerned between them. We have also met with three superior lateral incisors where it was impossible to determine which was the supplemental tooth.

Nodular Teeth.—Occasionally teeth are found having small, white, pearly nodules on their necks, or upon the roots near the termination of the enamel. These enamel nodules consist of a thick layer of enamel covering a cone of dentine, which projects from the neck or root of the tooth, and contains dentinal tubuli. They are similar to the excrescences in the form of extra cusps, which are sometimes found on the crowns of the teeth, especially the molars, and the enamel cov-

ering them is formed by a true enamel organ. These nodules are of physiological interest only, as they do not give rise to any pathological symptoms. They are a variety of dental exostosis which is extremely rare and difficult to account for. Sometimes they may be mistaken for supernumerary teeth, and an attempt to remove them may result in the extraction of the tooth to which they are attached.

Figs. 69 and 70 represent permanent teeth with nodules of enamel attached to the necks and sides of the roots.

Odontomes.—This term has been generally applied to tooth tumors developed from the hard tissues of the teeth, but it is now restricted to those irregular masses of dentinal tissues which result from some hypertrophied condition of the tooth papilla or formative pulp. In such cases the irregular mass consists of dentine and enamel, bearing little or no resemblance to a tooth; and it originates after the commencement of calcification.

Fig. 71 represents an odontome consisting of an irregular mass of tooth tissues.



FIG. 69.



FIG. 70.

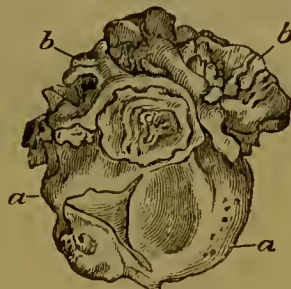


FIG. 71.

a. Smooth enamel-coated surface. b. Nodules of enamel.

The teeth described by Salter, Wedl, and others, under the name of "*Warty Teeth*," and which are composed of tissues hypertrophied and folded together into an irregular and complicated mass, afford a fair example of odontomes.

It is not unusual for odontomes to remain in the mouth for a considerable time without causing trouble, but sooner or later they may give rise to inflammation followed by suppuration in the adjoining parts, when their immediate removal is necessary. Mr. John Tomes refers to a case where the body of the sphenoid bone was found to be the seat of a tumor containing dentine.

Figs. 72, 73 represent dental anomalies extracted from the mouth of an old woman seventy years of age, one of the hairy Burmese family, by Dr. J. A. Daly, and are described as follows by Dr. C. T. Caldwell:—

"I find two very remarkable instances of gemination or organic

union of two neighboring teeth. The measurements and outlines of the drawing are as near as possible correct. Figs. 72 and 73.

“The lines A B and C D are intended to show the position of the teeth in the jaw, the portions above A B and below C D indicating the parts exposed above the gum. They were covered by a thick layer of dark-brown concretion, the exact nature of which I have not determined.

“Fig. 72 shows the right second molar and wisdom-tooth of the lower jaw so completely joined together that both crowns and roots are united throughout their entire length. The two roots of the second molar may be easily made out in the specimen, and just behind them, and completely fused with them, is the connate root of the wisdom-tooth.

“Still more remarkable than this is the specimen represented by Fig. 73, wherein the union of two upper molars is confined to the roots, which are so welded or blended together as to leave but little trace of the several roots. This specimen was at first supposed to be a large-sized molar



FIG. 72.

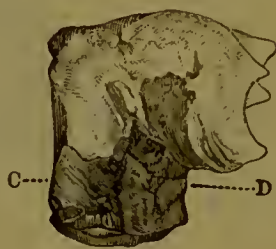


FIG. 73.

with an enormous exostosis, but a section through the parts shown in the drawing disclosed a pulp-cavity, and close examination revealed the fact that this portion of the mass is in reality the crown of a tooth, made up of enamel, dentine, and pulp cavity, filled with nerve and nutrient vessels, as in ordinary teeth. The tubercles or cusps, having never been subjected to wear, are in a perfect condition on what should have been the top or free surface of the crown, while the roots had become coalescent with those of its neighbor in such a manner that only one of the united teeth could assume an upright or natural position in the jaw, the other being forced into a horizontal position, with only a side protruding above the surface of the bone.

“This gemination or coalescence of contiguous teeth occurs during an early stage of their development, and is due to absorption of the intervening bony tissue caused by pressure, where, as in this case, several very large teeth crowd themselves into a very small mouth.”

Syphilitic Teeth.—Mr. J. Hutchinson was the first to call attention to a class of malformed permanent teeth, the result of inherited syph-

ilis, and he asserts that certain deviations in the forms of teeth are valuable as diagnostic marks of the existence of syphilis of a congenital constitutional type, and he classes them with syphilitic interstitial keratitis. This author describes syphilitic teeth as follows: "In those who had cut their permanent teeth the condition of the incisor teeth was very peculiar, both in form, color, and size. As a diagnostic of hereditary syphilis, various peculiarities are often presented by the others, especially the canines; but the upper central incisors are the test teeth. When first cut, these teeth are short, narrow from side to side at their edges, and very thin. After awhile a crescentic portion from their edge breaks away, leaving a broad, shallow, vertical notch, which is permanent for some years, but between twenty and thirty usually becomes obliterated by the premature wearing down of the teeth. The two teeth often converge, and sometimes they stand widely apart. In certain instances in which the notching is either



FIG. 74.



FIG. 75.

wholly absent or but slightly marked, there is still a peculiar color and a narrow squareness of form, which are easily recognized by the practiced eye. . . . Indeed, there can be no doubt whatever as to the truth of the assertion that malformed upper incisors (permanent set) are all but invariably coincident with this disease."

Henry W. Williams, M. D., Professor of Ophthalmology in Harvard University, confirms Mr. Hutchinson's observations, and says: "The central incisors of the second dentition have a peculiar crescentic notch at their lower margins, and the lateral incisors and canines, as well as the molars, are often small, peg-shaped, and with tuberculated prominences upon their surface. They are, perhaps, also irregularly set in the jaw, and of bad color, or prematurely decayed."

Figs. 74 and 75 represent syphilitic teeth in a boy and two girls, aged respectively twelve, fourteen, and seventeen years.

Mr. John Tomes describes these teeth as being of "a dusky, opaque appearance, and are small relatively to the size of the jaws, so that distinct intervals are left between them; moreover, they are of a very soft character, so that they speedily become worn down, and the characteristic transverse notch obliterated." Mr. Hutchinson remarks: "Inasmuch as specific inflammations do not occur during the period of intra-uterine life, the teeth belonging to the deciduous series are not liable to be affected, though they may be lost by exfoliation consequent on stomatitis and periostitis. On the other hand, the occurrence of specific affections of the mouth soon after birth may be readily supposed to affect the permanent teeth which are at this time developing, and certain characters are enumerated as indicative of such interference with the growing teeth."

Deviations of the teeth from the normal condition are so numerous and varied in their character, that it would be impossible to describe all of them.

Under the title of "*dilaceration*," Mr. John Tomes describes a condition of tooth resulting from displacement of the calcified portion of a tooth from the tissues which were instrumental in its production, the development being continued after the normal position of the calcified portion was lost; for example, the crown of an incisor when partly formed may move from its position upon the pulp, and be turned outward or inward, or to either side, and there remain in a state of rest, the development of the tooth continuing with the displacement of one-half of the crown permanently preserved.



FIG. 76.

Fig. 76 represents three cases of dilaceration, two incisors and a bicuspid.

Teeth have also been found with the root at the apex expanded into a cup-shaped disc, on the margins of which are

several openings or foramina for the entrance of the nerves and vessels. Also teeth with dentine excrescences in the form of nodules growing from the wall of the pulp-chamber. Sometimes these nodules of secondary dentine almost fill the pulp-chamber, while the parenchyma of the pulp is extensively occupied by small granules. Such excrescences frequently cause pain of neuralgic character. The devitalization of the pulp is the only treatment.

Dilated roots of teeth are caused by the dentinal pulp becoming hypertrophied into a globular structure of considerable size, and when calcified forming an osseous mass, often larger than the tooth itself. Such tumors are composed of an outer layer of cementum,

and a thin shell of dentine enclosing a voluminous pulp, which may or may not be calcified. Dilated roots of teeth may occasion pain when the jaws are opened, with expansion of the jaw at the alveolar portion.

Malformed teeth also result from interrupted development of the dental tissues, which is manifested by the crowns being irregularly grooved or pitted and smaller than the natural size. The incisors are generally thin and atrophied, and the cusps of the canines and molars sharp-pointed, such teeth being deficient in quantity and quality of their tissues, and of a yellow, opaque color. Malformed teeth are sometimes, though rarely, met with where the roots are perfectly developed, while the crowns present a peculiar deficiency, and consist of rudimentary formations which appear like small irregular masses of dentine without any enamel covering. These crownless teeth, as they may be styled, are sometimes found worn level with the gum line.

Another anomaly of tooth-structure, and one that is also very rare, consists of teeth with crowns flattened in an antero-posterior direction, the jaws presenting an edentulous appearance. The sulci of such teeth are misshapen, and the cusps are like narrow ridges.

Exostosed teeth are also included in those that deviate from the normal form, one of the most remarkable instances of which was a case exhibited by Mr. Tomes—a molar of the upper jaw, removed from a patient aged forty-one, who had long suffered pain in the jaw, from which a fistulous passage led through the cheek. Fig. 77 represents this case. (See “Exostosis of the Teeth.”)

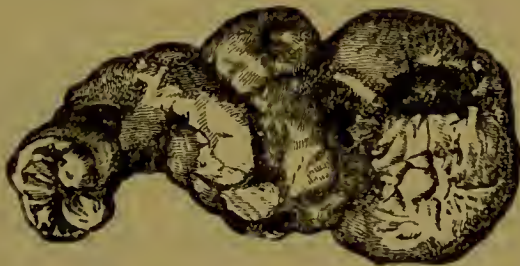


FIG. 77.

Unerrupted or Impacted Teeth are often malformed, and may cause dentigerous cysts. (See “Dentigerous Cysts.”)

Organic Defects of Structure.—Malformation of teeth caused by organic disease, or disease of tooth-structure, is less frequent in its occurrence than any other disease to which these organs are liable; but as the progress of the affection usually terminates with the action of the causes concerned in its production, it has scarcely been deemed of sufficient importance to merit serious consideration. Hence its etiology and pathology have not been very carefully investigated.

Fig. 78 represents superior and inferior front teeth with crowns disfigured by irregular grooves and pits.

This affection consists in a congenital defect of structure in teeth rather than in the wasting, for want of nourishment, of any of the dental tissues. The congenital form of the disease is evidently the

result of altered function in a portion of one or more of the formative organs—if not of absolute degeneration, from vicious nutrition.

Teeth presenting these organic structural defects may very properly be divided into three varieties. Each has characteristic peculiarities which distinguish it from either of the others. Two are always congenital, and the other, although most frequently congenital, sometimes occurs subsequently to the eruption of the tooth.

First Variety.—The peculiarities that distinguish this variety from either of the others are, that it never impairs the uniformity and smoothness of the surface of the enamel, and is characterized by one or more white, or dark, or light brown, irregularly shaped spots, upon the labial or buccal surface of the tooth. It occurs oftener than the



FIG. 78.

third variety, and less frequently than the second. It rarely appears on more than one or two teeth in the same mouth, though several are sometimes marked by it. It is seen on the molars more frequently than the bicuspid, and much oftener on the incisors of the upper jaw than any of the other teeth. We do not recollect to have ever observed it on the cuspids of either jaw, nor on the palatine or lingual surfaces of the incisors.

The enamel is much softer on the affected than on the unaffected parts of the teeth, and may be easily broken and reduced to powder with a steel instrument. It seems to be almost wholly deprived, in these places, of its animal constituents, and to have lost its connection with the subjacent dentine. The size of the defective spots is

almost as variable as their shape, but the most harm resulting from them is the unsightly aspect they sometimes give to the tooth.

Second Variety.—This may be very properly denominated *perforating* or *pitting* defect; it gives to the enamel an indented or pitted appearance, the irregular depressions or holes extending transversely across and around the tooth. The pits are sometimes more or less distinctly separated one from another by prominent lines; at other times they are confluent, and form an irregular horizontal groove. Sometimes they penetrate but a short distance into the enamel; at other times they extend entirely through it to the dentine. Their surface, though generally irregular, usually presents a glossy and polished appearance—a peculiarity which always distinguishes this variety of the affection from erosion. The pits often have a dark-brownish appearance, though sometimes they have the same color as the enamel on other parts of the teeth.

This variety is never confined to a single tooth. Two, four, six, or more corresponding teeth are always affected at the same time in each jaw; and the corresponding teeth on either side precisely in the same manner and in the same place. When more than two are marked, the distance of the pits from the coronal extremity of the tooth varies, according to the progress made in the formation of the enamel at the time of the operation of the causes concerned in the production of the affection. For example, when the line of pits in the central incisors is situated about two lines from their cutting edges, it will scarcely be one line from the cutting edges of the laterals, and only the points of the cuspids will be marked. When the indentations are nearer the edges of the central incisors, they will be on the edges of the laterals, and the cuspids will have entirely escaped.

Sometimes the teeth are marked with two or three rows of pits, and when this is the case, the patient has had either two or three relapses; or has been attacked two or three times in succession with some disease capable of interrupting the progress of the formation of the enamel.

Although the incisors are more frequently marked with these indentations than any of the other teeth, the cuspids, bicuspid, and even the molars, are sometimes affected with them. When the disease attacks the molars, its effects are generally located on the grinding surface. The permanent teeth are more liable to be attacked than the temporary.

This variety occurs oftener than either of the others, and though it sometimes gives to the teeth a disagreeable and unsightly appearance, it rarely increases their liability to decay.

Third Variety.—In this variety the whole or only a part of the crown of a tooth may be affected; the dentine being often implicated as well as the enamel. The tooth usually has a pale-yellowish color, a

shriveled appearance, and is partially or wholly divested of enamel. Sometimes the crown is not more than one-half or one-third its natural size. Its sensibility is usually much increased, and its susceptibility to pain from external impressions is wonderfully excited by acids. It is also more liable than the other teeth to be attacked by caries. The root of the tooth is sometimes, though rarely, affected, and presents an irregular knotted appearance.

The disease is often confined to a single tooth, but it more frequently shows itself on two corresponding teeth in the same jaw. According to our observation, the bicuspid is more liable to be attacked than any of the other teeth. This variety occurs less frequently than either of the others; and, although it increases the liability of the affected organs to caries, they sometimes escape until the twentieth or thirtieth year of age.

The nature of this affection is such as not to admit of cure. The treatment, therefore, must be preventive rather than curative. All that can be done is to mitigate the severity of such diseases as are supposed to produce it, by the administration of proper remedies. By this means their injurious effects upon the teeth may, perhaps, be partially or wholly counteracted.

In some forms of this affection the teeth may not decay more readily than others, so that the only evil resulting is a disfiguration of the organs; but in others, and especially in the pitted variety, it may be necessary to insert fillings at an early age. When the cutting edges of the incisors only are affected, the diseased part may sometimes be removed without injury to the teeth.

CHAPTER XI.

ORIGIN AND DEVELOPMENT OF THE TEETH.*

OF all the operations of the animal economy, none are more curious or interesting than that which is concerned in the production of the teeth. In obedience to certain developmental laws, established by an all-wise Creator, it is carried on from about the sixth week of intra-uterine existence, with the nicest and most wonderful regularity until

* The study of the "origin and development of the teeth" should begin with the "development of the bones of the head and face" and the "description of the mucous membrane," to which subjects the reader is referred.

completed, and excites in the mind of the physiologist the highest admiration.

From small papillæ, observable at a very early period of fetal life, the teeth are gradually developed, and as they increase in size, the papillæ assume the shape of the crowns of the several classes of teeth they are respectively designed to produce. Having arrived at this stage of their formation, they now begin to dentinify, first upon the cutting edges of the incisors, the apices of the cuspids, bicuspid, and eminences of the molars; from thence the process is continued over the whole surface of their crowns, until they become invested with a complete layer of dentine; and so layer after layer is formed, one within the other, until the process of solidification is completed. Before the appearance of the dentinal germ or papilla, however, or coincident with the development of the latter, the organ for the formation of the enamel of the teeth begins to form, and when this enamel organ, which arises in the form of a cord, has acquired the appearance of a hood or cap, the dentinal papilla is so far developed that its surface is covered with cells (odontoblasts) engaged in the formation of the dentine.

In the meantime, and in anticipation of the loss of the temporary teeth, a second set is forming, and as the teeth of the one series are removed, they are promptly replaced by those of the other. Thus, by a beautiful and most admirable provision of Nature, the first set of teeth, intended to subserve the wants only of childhood, while the jaws are too small for the reception of such as are required for an adult, are removed and replaced by a larger, stronger, and more numerous set.

Commencing the description of the development of the teeth with the condition of the jaws of the embryo at the period of the formation of the organs which compose the "dental follicle," namely, the enamel organ, the dentinal germ or papilla, and the follicular wall or sac, there is at an early period no trace of osseous tissue in the *lower* jaw, the maxillary arch having within its component elements a symmetrical cartilaginous band, which extends its entire length, as far as the frame of the drum of the ear, and which is known as "Meckel's cartilage." This cartilage acts a transitory part only, until osseous tissue is developed, first by calcification, and afterward by ossification, when it disappears. (See Development of the Bones of the Head and Face. Figs. 2, 3, and 4.)

As regards the *upper* jaw, the same period of evolution as that of the lower jaw marks the union of the maxillary germs with the median or inter-maxillary germs, which occurs in the human embryo about the fortieth or forty-fifth day. On the surface or rounded portion of

the two maxillary arches thus formed, and which later constitute the alveolar border or process, a depression or groove, called the "dental groove," appears, which, however, is so completely filled or "heaped up" with a bed of epithelial cells as to form a protuberance or smooth ridge, destitute of any fold or depression whatever.

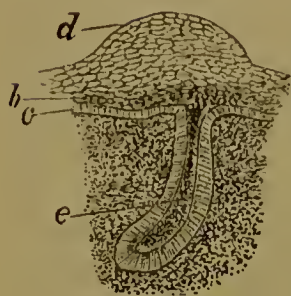


FIG. 79.

d. A mass of epithelium—the "dental ridge." *b.* Younger layer of epithelium. *c.* Deepest layer of epithelium—the prismatic or columnar stratum. *e.* Enamel germ.

This ridge (Fig. 79) is composed of a thick bed of epithelial cells, which, however, on its sides form a coat of a few rows of cells only, and does not include any other well-defined tissue unless it be some vessels, nerves, and muscle-fibres in process of development.

The principal structures of the teeth are derived from such elements as compose the epithelial structure and the tissues beneath which represent the corium and cellular tissue of the mucous membrane, beneath which is the ossifying substance of the jaw—the enamel being formed from the epithelium which fills the dental groove and constitutes the rounded projection or smooth ridge, and the dentine and cementum (crusta petrosa) from the deeper structures of the mucous membrane.

Development of the Enamel.—First, as to the development of the enamel, which is very similar to that of the hair follicle. About the sixth or seventh week of fetal life, the epithelium fills the groove or

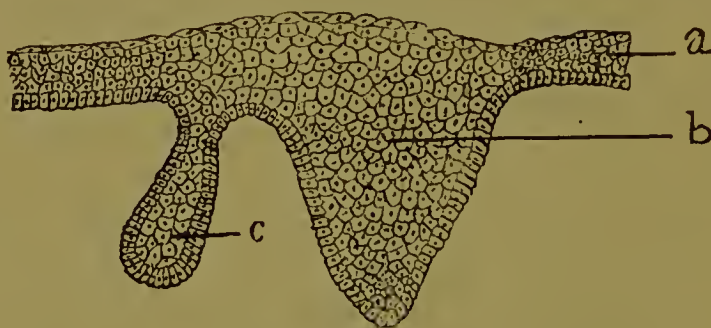


FIG. 80.

a. Flat layer of epithelium. *b.* Proliferation of cuboidal layer, forcing columnar layer downward, producing V-shaped appearance. The removal of these upper layers leaves the "primitive dental groove." *c.* Lamina from which arise the epithelial cords of enamel organs.

depression on the surface of the jaw so full that a small, rounded projection or ridge is formed, from the under surface of which a process sinks into the tissue beneath, the outlines of which resemble in shape the letter V with the apex slightly inclined toward the inner surface (Fig. 80). This epithelial process or band is simply a prolongation of the natural covering of the mouth, which sinks into the embryonic

tissue of the jaw, and forms for itself a groove which it completely fills, and is composed of the same histological elements as the epithelium of the mucous membrane of the mouth.

When this epithelial band is fully formed it presents two surfaces, an external and an internal, and from the latter a process is given off which forms the epithelial lamina. This epithelial lamina is a continuous process extending over the entire epithelial band, being an inflection of the band itself, and its elements are the same, namely, polygonal cells inclosed by a layer of prismatic cells.

The "dental follicle," which, as was before stated, consists of the enamel organ, the dentinal germ or papilla, and the follicular wall, is developed from points on the free

extremity of the epithelial lamina.

These follicles appear as small tubercles arranged at intervals on the free margin of the lamina, and correspond in number and location to the future deciduous teeth, being the primitive germs of the dental follicles, which retain their connection with the lamina by means of a slender cord, which gradually increases in length as the development of the germ at its extremity progresses. This germ constitutes the enamel organ, while the neck or cord in its progressive lengthening merely serves as a temporary

connection with the lamina. This germ presents a spherical form in its early stage (Fig. 81), and is composed of an external layer of prismatic cells (ameloblasts) including a mass of polygonal cells. The younger layer, described as "infant cells," owing to the active cell-multiplication which takes place at the point where the epithelial cord for the tooth is to arise, sinks into the substance of the tissue beneath the epithelium in the form of a pouch. Some contend that the cells of this infant layer are not columnar, but are oval or spheroidal. The enamel organ at about the fourth month of the development of the embryo has undergone very considerable changes, the primitive polygonal cells which compose the central mass or middle region of this organ have been transformed into stellate bodies differing in appearance from the primitive cells, a process, however, which is confined to the cells of the enamel germ, and which does not take place



FIG. 81.—PRISMATIC DENTAL FOLLICLE.

c. Prismatic or columnar cells. *d.* Large polygonal cell of the epithelial band. *F.* Small cells of the epithelial laminae.

in the cells of the epithelial cord or lamina, thus affording evidence that the constitution of the one differs from that of the other.

These stellate cells (Fig. 82) are composed of a central nucleus surrounded by a transparent or finely granular mass, which mingles with the neighboring elements.

They occupy at first only the center of the enamel organ, and those near the periphery preserve their primitive polygonal form, but become stellate as the organ increases in size, and are formed from the original elements composing the internal mass of the enamel organ, being epithelial in their nature.

After a time the base of these stellate cells presents the regular prismatic form of a hexagon (Fig. 83).

During this modification of the enamel germ, no change appears to take place in the epithelial lamina.

The primitive enamel germ at length loses its original spherical



FIG. 82.—STELLATE CELLS OF THE ENAMEL ORGAN.
(Diagrammatic, from *Frey*.)



FIG. 83.—REPRESENTS THE HEXAGONAL FORM ASSUMED BY THE BASE OF THE STELLATE CELLS.

form, and becomes somewhat cylindrical, pursuing a horizontal course until it undergoes a considerable increase in length, when, by an abrupt turn, it takes a vertical direction and sinks into the tissues of the jaw.

During such a progress the cord acquires a length in accordance with the requirements of the jaw.

After the epithelial cord has changed its course from a horizontal to a vertical direction, its extremity expands and assumes a club-shape, on account of the multiplication of the polyhedral cells of which its greater portion is composed, and also of the prismatic cells that surround it. This expanded extremity also becomes somewhat spherical, and its upper portion corresponds to the point of connection with the cord, while the lower portion points toward the base of the lower jaw.

This condition represents a fully formed enamel organ, which is the

first trace of the dental follicle. Very soon the lower portion of the enamel organ becomes concave, and assumes the form of a cap or hood, although still retaining its connection with the epithelial cord. At this stage in the development of the enamel organ the dentinal germ or papilla makes its appearance.

During the development of the primitive epithelial cord, lateral germs similar to small rounded nodules, in the form of varicosities,

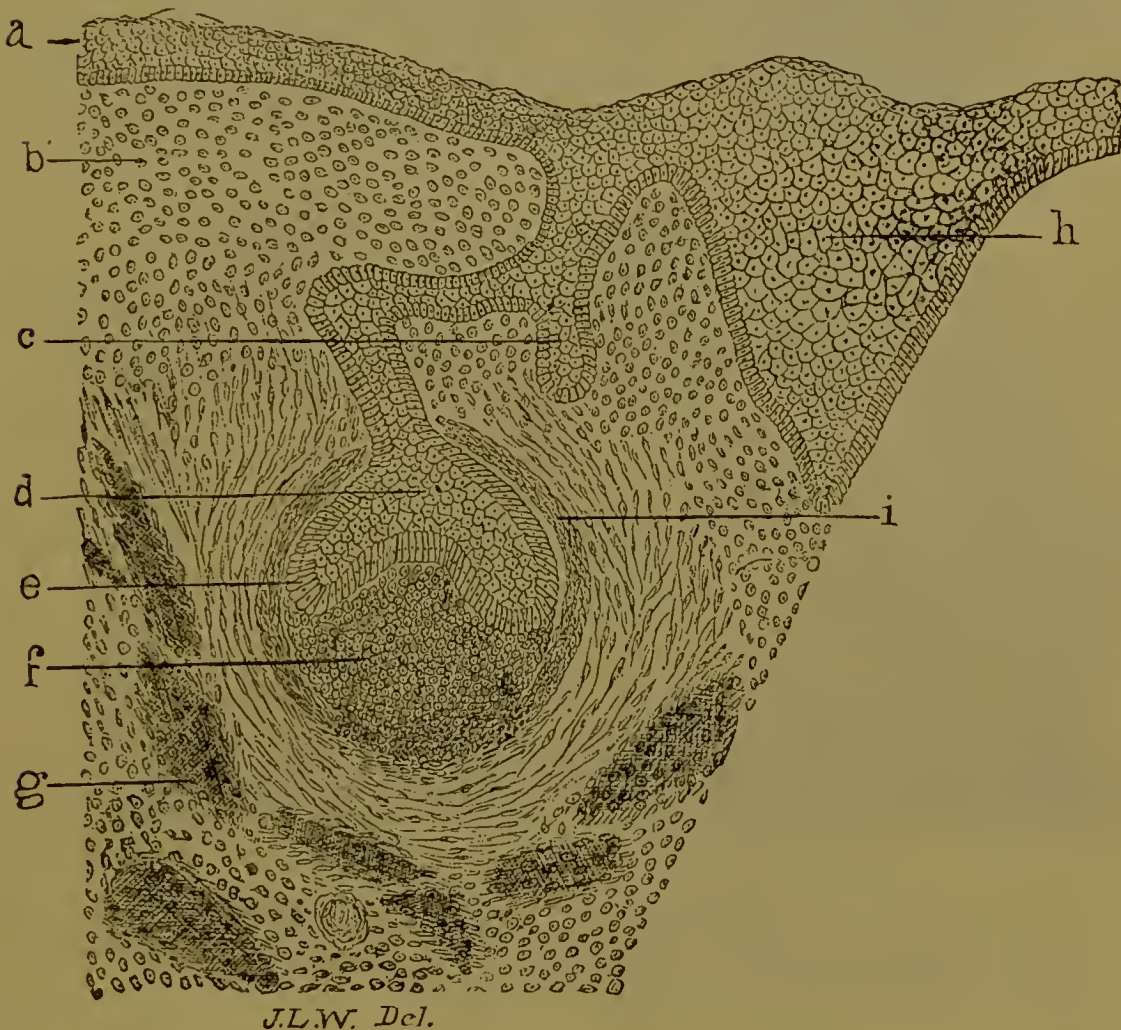


FIG. 84.

- a.* Epithelial layers of mucous membrane lining mouth. *b.* Embryonal corpuscles of dermal tissue of jaw. *c.* Budding of cord of permanent tooth from cord of temporary tooth. *d.* Enamel organ of temporary tooth. *e.* Columnar or prismatic layer of cells from which ameloblasts or enamel cells are formed. *f.* Dentine germ formed from embryonal corpuscles of dermal tissue. *g.* Commencing ossification of inferior maxilla. *h.* V-shaped band, resulting from proliferation of cells of cuboidal layer. *i.* Development of connective-tissue cells from embryonal corpuscles, forming sac which incloses tooth-germ.

make their appearance, and which, according to Magitot, resemble an irregular chaplet or chain. These lateral germs are composed of small polyhedral cells, like those of the cord itself, with walls formed of a layer of prismatic cells in continuation of the Malpighian layer of the epithelium. From these lateral germs or masses, at a later period, after the cord is ruptured, epithelial prolongations arise.

The primitive cells during the early stage of evolution present the same characteristics on all parts of the periphery, but as soon as the dentinal germ or papilla begins to appear these primitive cells on the concave surface lengthen, while those of the convex surface decrease in size until they disappear entirely, before the atrophy of the enamel pulp; and those of the internal surface remain for the formation of the enamel organ.

Besides increasing in length, the prismatic cells of the concave surface of the enamel organ undergo changes, their extremities, directed toward the center of the enamel organ, forming slender processes, which either unite, or are continuous with filaments from surrounding

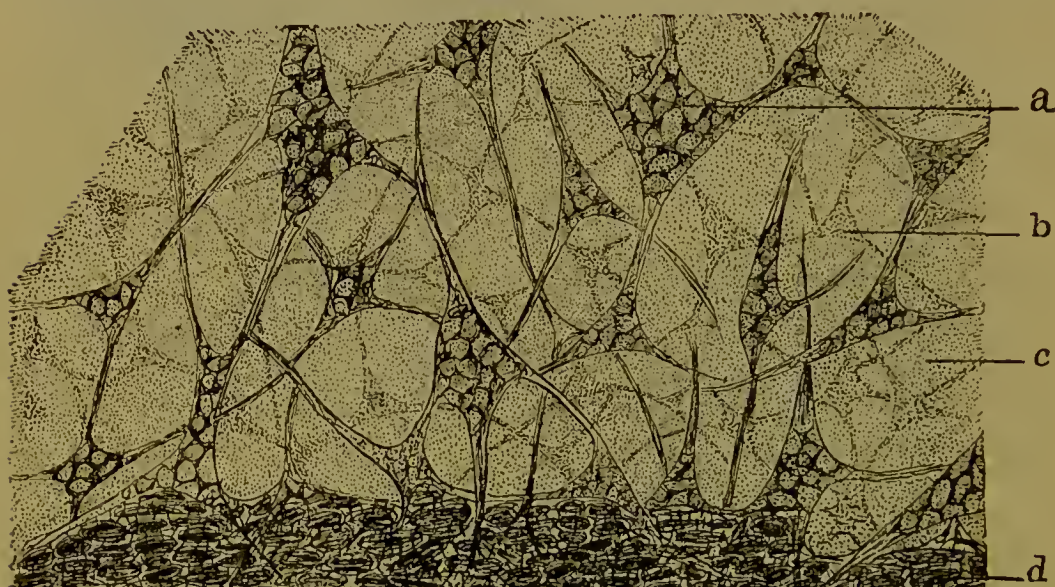


FIG. 85.—ENAMEL ORGAN AND "NASMYTH'S LAYER" OF CELLS, DRAWN UNDER A MAGNIFYING POWER OF 1800 DIAMETERS.

a. Portions of the reticulum which lie exactly in focus; the points of intersection are seen to be made up of a finer and more delicate reticulum. *b.* Parts which lie a little beyond focus. *c.* Granular matter held in the meshes of the reticulum. *d.* "Nasmyth's membrane," or layer of flat cells, just outside of enamel cells.

cells, which constitute the portion of the enamel organ designated as the *stratum intermedium*. The stratum intermedium consists of cells which, according to Mr. Tomes, are intermediate in character between those of the bordering epithelium and the stellate reticulum, being branched, but less conspicuously so than the stellate cells with which they are continuous on the one hand, and on the other with the enamel cells. According to Waldeyer, Hertz, and Hannover, since the enamel cells may be frequently seen connected at their lower extremities with the cells of the stratum intermedium, a multiplication of enamel cells from the cells of this stratum, in the direction of their length, may be admitted to occur.

According to Dr. G. V. Black, and quoted by Dr. M. A. Dean, "just before the classification, and even before the odontoblasts make their appearance, the ameloblasts (prismatic cells), and the tissues of the pulp are separated by a well-marked double pellucid layer, which in sections appears as a double band." This double band is represented in Fig. 86 by the two white parallel lines, *A A*, the upper one being the tissue which is identical with the *membrana præformativa* of Huxley, while the lower one represents the *basement membrane* of Ladd and Bowman, and the *membrana præformativa* of Raschkow.

After the epithelial cells are changed into hexagonal prisms, these anastomose and form the hexagonal rods characteristic of fully matured enamel.

The epithelial covering on the outer surface of the enamel remains distinctly perceptible, and after the eruption of the crown of the tooth this layer, which is known as the "dental cuticle"—*cuticula dentis*—and also as "Nasmyth's membrane," may be separated from the enamel surface beneath it by strong acids, when the hexagonal depressions of enamel prisms are apparent, and on the application of nitrate of silver the characteristics of epithelium appear.

Dr. J. L. Williams, in an able article on "embryology," dissents from the opinion of Legros and Magitot concerning the function of the *membrana præformativa* of Raschkow, and positively denies that it has any modifying influence in the process of the development of the teeth; and, while he is not prepared to deny *in toto* the existence of this membrane, says that an examination of many specimens failed to discover this structureless, transparent tissue; and he asks, "How is it possible that the odontoblasts, which are more than $\frac{1}{30000}$ of an inch in diameter, can be developed in a membrane which Beale says is "certainly less than the $\frac{1}{20000}$ of an inch in thickness." Dr. Williams also remarks: "It has been supposed that the so-called ameloblasts, or enamel cells, are formed directly from the layer of columnar or prismatic epithelium which covers the face of the enamel organ." But preceding the development of the enamel cells, the original pris-

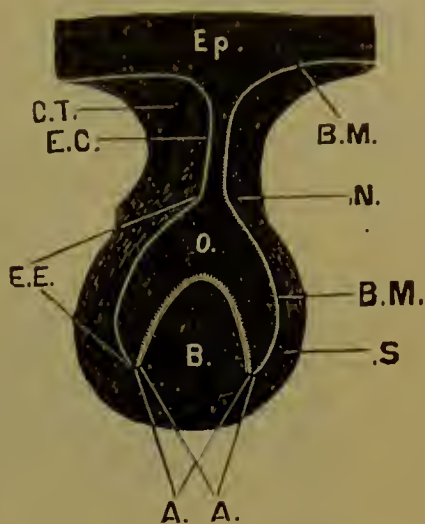


FIG. 86.—*B. M.* Basement membrane. *N.* Neck. *S.* Sac or follicular wall. *O.* Enamel organ. *B.* Bulb. *E. E.* External epithelium of the enamel organ and the basement membrane. *E. C.* Epithelial cord. *C. T.* Connective tissue surrounding the enamel organ. *Ep.* Epidermis or oral epithelium.

The parts embraced between the points where the divergent lines *A. A.* terminate are: (1) The concave face of the enamel organ, lined with a layer of ameloblasts, or the "internal epithelium." (2) The *membrana præformativa* of Huxley, or the tissue composed of the basal coverings of the ameloblasts. (3) The *membrana præformativa* of Raschkow, or the basement membrane. (4) The dentine bulb itself. Diagrammatic.

matic cells break up or divide into round, nucleated corpuscles, which change is denominated by Professor Heitzmann and Dr. Atkinson a return to an embryonal condition."

"From these embryonal corpuscles are developed the enamel-forming cells, and also an outer layer of smaller cells, from which is formed Nasmyth's membrane."

The same author also regards the enamel organ as a "true secreting

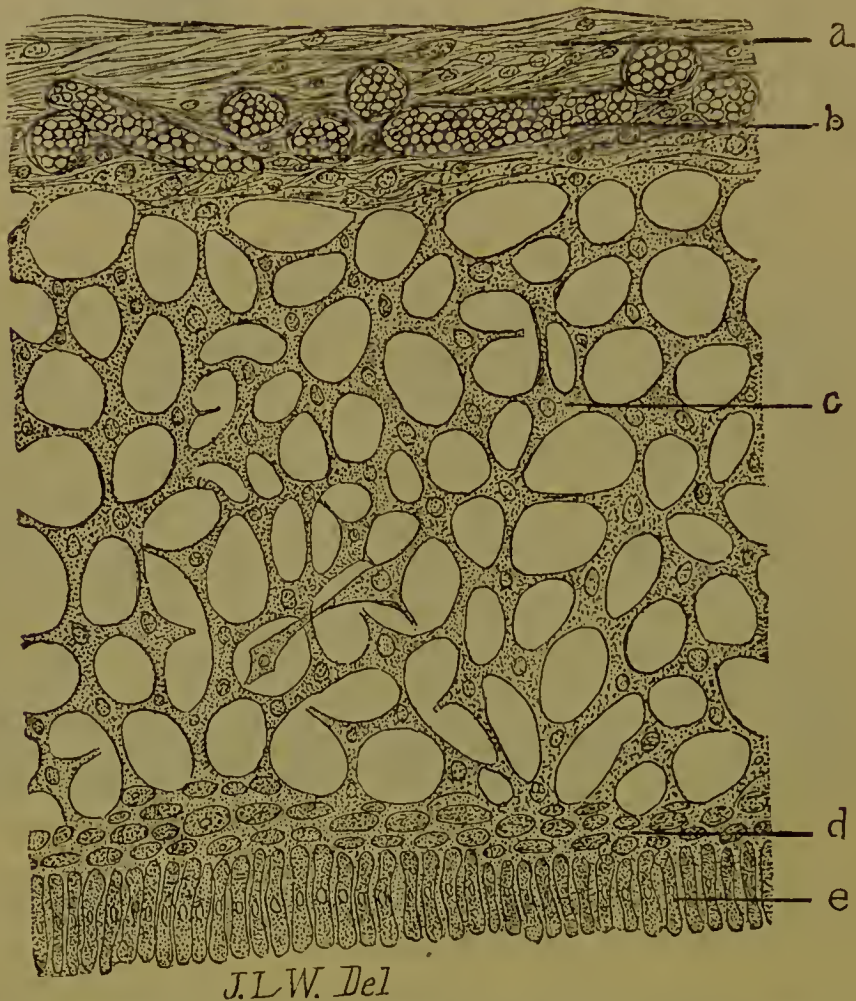


FIG. 87.—The Specimen from which this drawing was made was placed under a one-tenth inch immersion lens, magnifying about 800 diameters.

a. Connective tissue of tooth-sac. b. Capillary vessels cut transversely and longitudinally, and filled with blood-corpuscles. c. Reticulum of enamel organ. d. Round and flat layer of cells, forming the so-called "Nasmyth's membrane." e. Ameloblasts or enamel cells.

organ," and that the material for the formation of enamel has no other evident source.

Development of the Dentine.—As the epithelium is undergoing this peculiar development into the enamel organ, a projection of the corium of the mucous membrane of the fetal jaw rises up to meet it out of the dental groove. This projection is the dentinal papilla or germ, which is described, after Dursy and Waldeyer, as a ridge, "the

intervening parts of which are atrophied so as to leave papillæ or germs which become coated all over by the enamel organ, and thus the saccular stage of the teeth is produced, the papillæ which are to



FIG. 88.—*Drawn under the same magnifying power as Fig. 74.*

a. Connective-tissue cells of tooth-sac. *b.* Reticulum of enamel organ. In this drawing it is seen that the reticulum holds in its meshes very large, soft, granular corpuscles, heretofore known as the gelatinous fluid of the enamel organ. *c.* Breaking down of columnar layer of cells into embryonal corpuscles, from which ameloblasts are developed.

form the bulk of the teeth being coated with a vascular connective tissue, isolated by the enamel organ and separated from each other by the growing (osseous) tissue of the fetal jaw."

Dursy, according to Waldeyer, says: "The first germ of the dentine appears in the dental *sacculus*, as a dark semilunar area at the bottom of the dental groove—that is to say, of the enamel germ—coetaneously and continuously with which it is developed along each half of the jaw. At certain points corresponding to the position of the subsequent teeth, the young structure develops in the form of papillæ, projecting against the enamel germs, while the remainder atrophies. The two horns of the semilunar mass (as seen in section) extend from the base of the dental papilla some distance upward, and embrace the dentine germ and enamel organ."



FIG. 89.

a. Meckel's cartilage. *b.* Traces of ossification. *c.* Lowest layer of Malpighian stratum. *d.* Oral epithelium. *F.* Ameloblastic or prismatic layer. Lower *F.* External layer of enamel organ. *g.* Stellate reticulum of the enamel organ. *H.* Dental germ, or papilla. *I.* Follicular walls.

According to Dr. Sudduth, the epithelial cord does not penetrate the underlying tissue searching for a dentinal papilla, but it has the power to superintend the differentiation of a papilla for itself.

As the dentinal papilla or germ increases in height, it assumes a slightly oblique direction in relation to the axis of the follicle, and at the same time becomes constricted at its base, thus forming a neck at the line where the enamel organ is reflected back upon itself (Fig. 89).

The follicular wall, which forms a part of the dental follicle, first appears as a process arising from the base of the papilla, to the neck of which it is attached like a slight collar. Its development begins as

soon as the small mass which constitutes the dentinal germ assumes a hemispheric form. The follicular wall, by its gradual upward growth, at length embraces and isolates both the enamel organ and the dentinal papilla, and during its evolution, from being composed of embryoplastic elements, by degrees assumes the appearance of a distinct laminated membrane, which may be separated from the adjacent tissue, except at the base of the papilla to which it remains adherent. According to both Kölliker and Huxley, the transparent stratum (*membrana præformativa*) which invests the dentinal papilla reflects itself back on its internal surface, and thus lines the whole inner surface of the follicular wall.

As the evolution of the follicular wall progresses, it closes over the contents of the dental follicle, which, besides the wall, consist of the enamel organ and the dentinal papilla; the enamel organ being subjacent to the follicular wall, to which it conforms in such a manner that, while the external face of the organ is in relation with the wall, the lower concave face is in immediate contact with the papilla. The dentinal papilla occupies the lower and central portion of the follicular sac.

The enamel organ fills the entire space between the sac wall and the papilla, terminating at the base of the latter in a rounded margin which forms the dividing line between the prismatic cells which cover its concave and convex surfaces (Fig. 90). The dental follicle is of an ovoid form, and varies in size according to the class of tooth to be developed from it; and when it is completely formed, it remains inclosed within the embryonal tissues of the jaws, with which it is at first only slightly connected.

When the rupture of the epithelial cord occurs, it loses its communication with the mucous membrane, and forms no connection with the maxillary bone, as the alveolar processes are not developed until a later period.

The rupture of the epithelial cord, which brings about the isolation

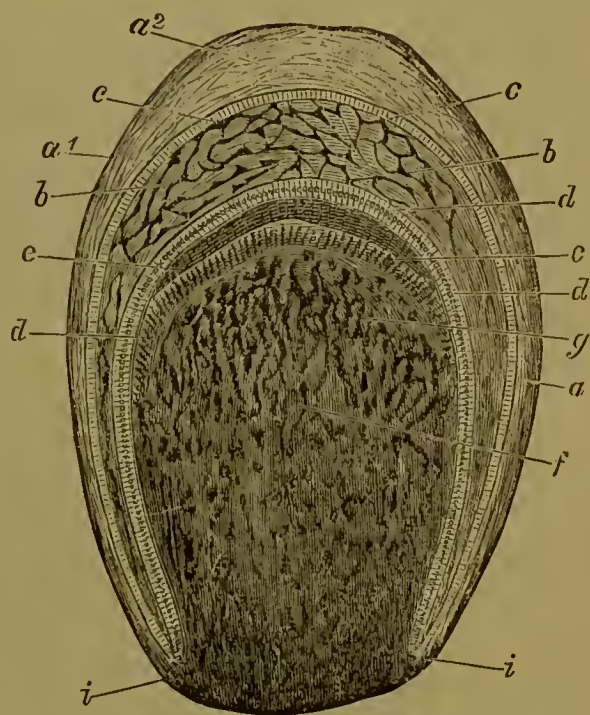


FIG. 90.—*a*. Wall of the sac, formed of connective tissue, with its outer stratum *a*¹ and its inner *a*². *b*. Enamel organ, with its papillary and parietal layer of cells. *c*, *d*. The enamel membrane and enamel prisms. *e*. Dentine cells. *f*. Dental germ and capillaries. *g*, *i*. Transition of the wall of the follicle into the tissue of the dental germ.

of the dental follicle from the mucous membrane, is due to the upward growth of the follicular wall, which closes over the top of the enamel organ, beneath which is the papilla, the union of the edges of the wall producing compression or strangulation of the cord at that point. At this period of evolution, the saccular stage, the dental follicle is completed, and from the cells of the dentinal papilla a soft matrix of animal matter is formed, which becomes impregnated with calcareous matter to form the complete dentinal tissue, while in the interior of the cavity of the dentine cells are formed, which continue to form new matrix for a considerable time.

After the dentinal papilla has become coated over by the enamel organ, and the saccular stage of the teeth is produced, and the papillæ have become separated from each other by the developing tissue of the embryonic jaw, odontoblasts (dentine cells) begin to form. These odontoblasts are large nucleated cells of elongated form, containing numerous processes developed from the cells of the dentinal papilla, which at that early period consist of fine fibrous tissue with numerous cells.

The odontoblasts send out processes which, as they develop, calcify externally, the calcified portion forming the dentine, and the uncalcified part the dentinal fibrillæ, and the lateral branches of anastomosis whereby the tubuli or canals of the dentine anastomose. The remains of the odontoblasts form a cellular layer which constitutes the investment of the pulp lying between its nerves and vessels and the dentine. This cellular layer is known as the "ivory membrane"—*membrana eboris* of Kölliker.

The enamel organ is non-vascular, but a network of vessels is furnished to the follicular wall and the dentinal papilla from the surrounding tissues.

At the period when the epithelial cord is ruptured, the cells composing the epithelial lamina become greatly increased in number, and irregular proliferations or "buddings" occur, which wander by different courses into the deeper portions of the embryonal tissue. These buddings differ in form, sometimes in that of cylinders which retain their connection with the primitive lamina; but frequently this connection is absorbed, and an epithelial mass is set free. Clusters of these masses occasionally take the globular form, resembling those in the lamina itself, but frequently they become absorbed and disappear before the development of the tooth is completed. At the time the absorption of the epithelial lamina is taking place, changes precisely analogous are transpiring in the severed epithelial cord.

From the remains of this cord processes are given off, which at

times become quite numerous, and may remain almost to the time of the eruptive stage of the tooth.

The direction of these processes is toward the epithelium, and they consist of the same polyhedral cells as the cord and lamina, but are never invested with prismatic cells. All these epithelial proliferations finally disappear by absorption, unless some such masses may become detached and wander into the deeper tissues; for it is considered by some eminent histologists that a dentinal papilla or germ may originate from any point of the dentinal sheet of tissue with

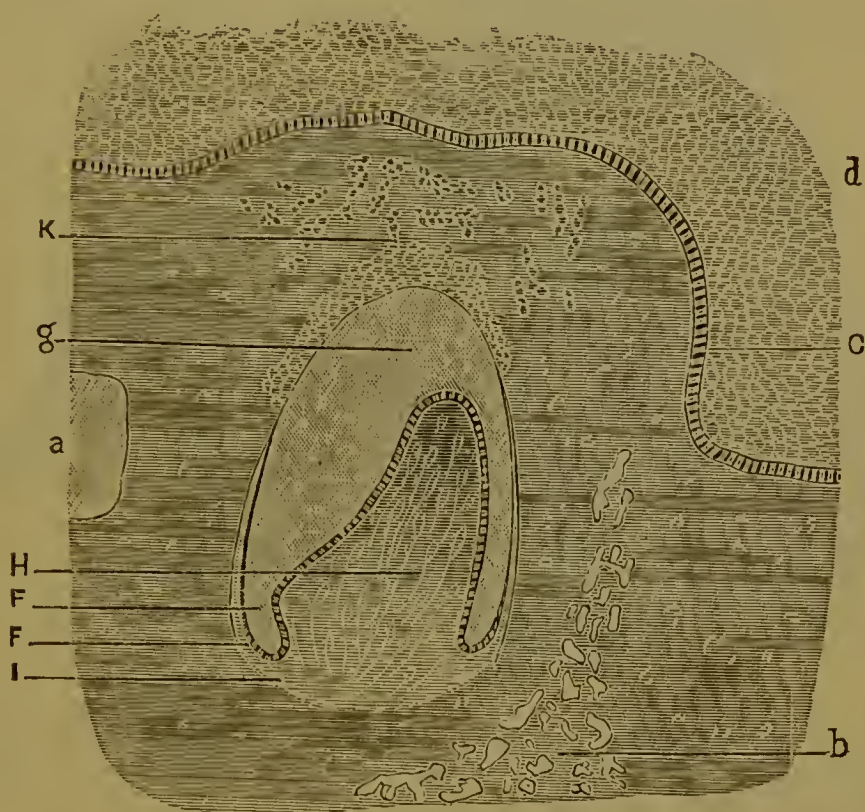


FIG. 91.

a. Meckel's cartilage. *b.* Traces of ossification. *c.* Lowest layer of Malpighian stratum. *d.* Oral epithelium. *F.* Ameloblastic layer. *Lower F.* External layer of enamel organ. *H.* Dentinal papilla. *I.* Follicular wall. *K.* Buddings of epithelial cord.

which the epithelial mass comes in contact, and that it is solely through the influence of the enamel organ upon this tissue that the development of the dentinal papilla is induced.

Immediately after the rupture of the epithelial cord, the formation of the secondary follicle of the permanent tooth begins. There is no trace of the osseous tissue of the jaw at the time of the origin of the primitive epithelial cord. Bone first makes its appearance near the base of the follicles, forming a horizontal layer, and separating the groove of the follicles from the canal reserved for the vessels and nerves. From the layer or floor, lateral processes arise and form the dental groove, in which the follicles remain for some time without

being separated by transverse partitions, and it is only after the development of the crowns of the teeth has commenced that bony processes are thrown across the groove, forming receptacles for the lodgment of each follicle with an opening in the direction of the epithelial surface (Fig. 92).

Development of Cementum (Crusta Petrosa).—There appears to be a difference of opinion among histologists concerning the origin of the cementum. Magitot, in 1858, and again Robin and Magitot, in 1861, described a new tissue, which, some time before the formation of the first dentine cap, was supposed to exist between the follicular wall and the organs within it—the enamel organ and the papilla—



FIG. 92.—FROM THE UPPER JAW OF A KITTEN, ABOUT THE TIME OF BIRTH.

a. Oral epithelium. *b.* Bone of jaw. *c.* Neck of enamel organ. *d.* Dentinal papilla. *e.* Enamel cells. *f.* Stellate reticulum. *h.* Germ or papilla of permanent tooth, the enamel organ of which is derived from the primary cord.

differing from the other tissues in color, consistence, and structure, and upon which the formation of the cementum depended.

On the other hand, Kölliker, Waldeyer, Hertz, Kollman, and others, deny the existence of such a membrane or tissue, and ascribe the formation of the cementum (which resembles ordinary bone, as it contains canaliculi and lacunæ) to a periosteal origin—that it is developed from the deeper tissues of the fetal jaw by periosteal ossification, the process being similar to that of bone formation in other parts of the body.

Origin of the Permanent Teeth.—While Goodsir held that the follicles of the permanent teeth originate from a fold of the sac of the primitive or deciduous follicle, the later investigations of Kölliker and Waldeyer have shown that the permanent follicles of teeth that

have deciduous predecessors arise from certain prolongations of the primitive epithelial cord.

The germ of the permanent follicle originates at a point where the primitive epithelial cord merges into the enamel organ of the temporary tooth, and is an outgrowth of this cord (see Fig. 93). The permanent cord takes a vertical direction, and passes between the bony alveolar wall and the primitive follicle, and then along the inner or lingual face of the follicle, its elements being the same as those of the primitive cord.

The permanent dentinal papilla or germ sinks to the bottom of the osseous dental groove, where it soon loses its connection with the primitive follicle, though still retaining its relation with the epithelial lamina.

The primitive follicle, however, by the severance of its cord at a point just below where the germ of the permanent or secondary cord arises, loses all connection with the epithelial lamina, and develops as an independent body or organ.

The sinking of the follicle of the permanent tooth is soon followed by the entire series of phenomena which characterize the growth of every dental fol-

licle; and while the permanent follicle is being developed, the remains of the ruptured primitive cord which continues to be attached to the primitive follicle are subject to that "budding" process which invariably commences at the moment this cord is severed—about the fourth month, or quickening period. The direction of the permanent cord being vertical, its length is governed by the height of the alveolar border and the direction of the primitive follicle. When sinking into the substance of the jaw, the permanent cord always assumes a spiral form, and to such a degree that it can be readily distinguished

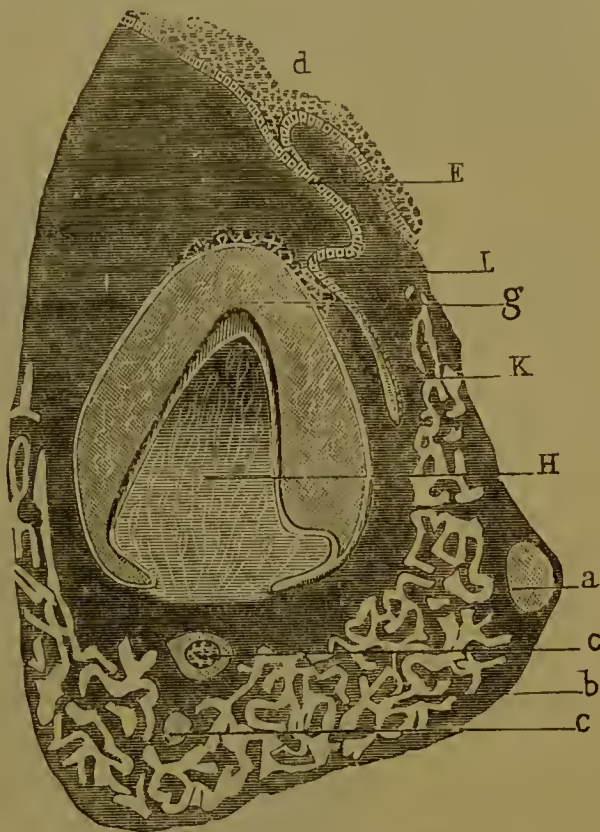


FIG. 93.—SECTION OF THE LOWER JAW OF A HUMAN FETUS.

9½ inches in length; corresponding to about the eighteenth week. (*Magnified 80 diam.*)

K. Cord or bourgeon of the secondary follicles. *L.* Points where its separation from the primitive cord is being effected. *a.* Meckel's cartilage diminished by absorption. *b.* Bone of the jaw. *c.* (Upper) dental artery; (lower) dental nerve. *d.* Epithelium. *E.* Originally the cord of the temporary follicle, but now the sole property of the permanent one.

from the primitive cord, as this latter is never so distinctly spiral in form as the former.

This spirality of form peculiar to the permanent cord is occasioned by the greater distance this cord must traverse in the more developed tissues of the jaw, to permit the permanent follicle to accomplish its passage to a point under the temporary tooth, and thus prevent the stretching of the cord and the disturbance of the parts with which the cord and enamel organ are connected. The spiral nature of the cord

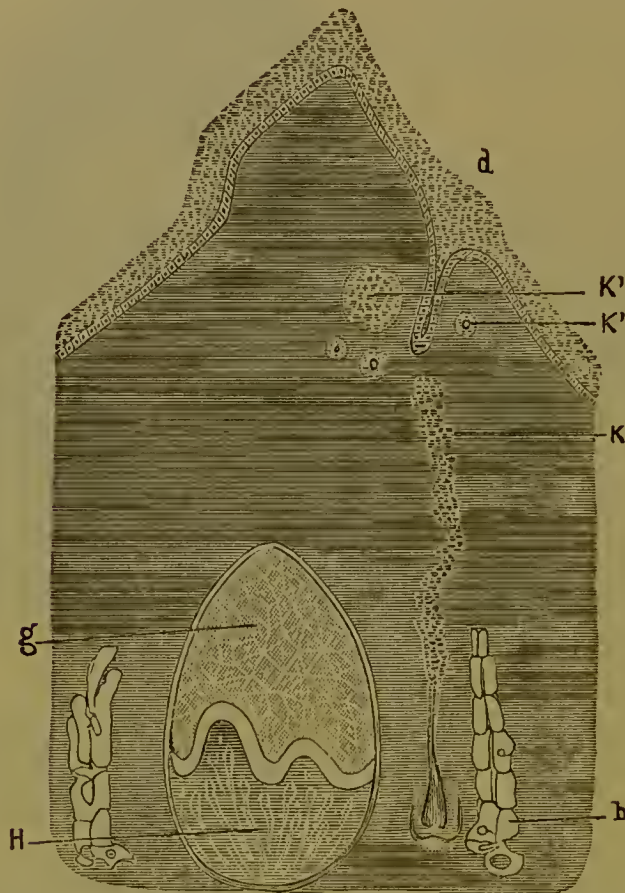


FIG. 94.—VERTICAL SECTION OF THE LOWER JAW OF A HUMAN FETUS. Measuring $18\frac{3}{4}$ inches; corresponding to nearly the thirty-ninth week of gestation. The figure represents a cut passing through the follicle of a bicuspid.
b. Bone of the jaw. *d.* Oral epithelium. *g.* Enamel organ. *H.* Dental bulb. *K.* Debris of the cord of a permanent follicle. *K', K'.* Epidermal globules. Follicle for the permanent tooth connected with the debris of its cord, *K.*

continues from its origin toward its termination in a rounded or club-shaped enlargement, similar to that of the extremity of the primitive cord, this enlargement representing the enamel organ of the permanent tooth.

At the period of the evolution of the permanent follicle, when the dentinal papillæ becomes unicuspid for the incisors and canines and multicuspid for the molars, the permanent epithelial cord, which has

already been for some time severed from the primitive cord and follicle, also loses its connection with the permanent follicle, and has no communication afterward with the epithelial lamina. This severance is soon followed by the separation of the permanent cord into fragments, which, as was before stated, bud and lengthen in different directions, and become mingled and confounded with those of the primitive cord, anastomosing with them to form a sort of plexus. Finally, all these epithelial masses atrophy and disappear.

The above description applies to the development of the permanent teeth that have temporary predecessors. But the origin of the permanent teeth that appear back of the temporary teeth, and have no deciduous predecessors, is entirely different.

The first permanent molar, the follicle of which makes its appearance during the fifteenth week of embryonal life, and only a few days after the greater number of those of the deciduous teeth, and yet does not erupt until about the sixth year, originates directly from the epithelium of the mucous membrane, the epithelial cord from which penetrates the fetal tissue in a region where no follicle has preceded it.

The second permanent molar originates from an outgrowth of the epithelial cord of the follicle of the first permanent molar, resembling in this respect the twenty anterior permanent teeth, but differing in the direction of its course. While the teeth derived from the temporary follicles pass over the lingual face of the latter to a position beneath them, that of the second permanent molar takes a horizontal direction for some distance, and then by an inflection takes its position at the posterior side of the follicle of the first molar, where it is developed in a line with those anterior to it (Fig. 92).

The origin of the third molar or wisdom tooth is effected in the same manner as that of the second permanent molar, as the epithelial cord that forms its enamel organ emanates from the cord of the second permanent molar. Hence we find the cord of the first permanent molar originating from the epithelium; that of the second permanent molar from the cord of the first permanent molar; and that of the third molar from the cord of the second permanent molar.

Dr. G. V. Black, whose extensive researches in dental histology are worthy of all praise, is of the opinion that, "although the epithelial cords of the twenty anterior permanent teeth generally arise from those of the temporary follicles, yet they do sometimes emanate directly from the epithelium of the mucous membrane."

If such is the case, the secondary or permanent epithelial cords may originate from either the primary cord, the temporary follicle, or the epithelial lamina. The follicles of the temporary teeth are developed during the period between the latter part of the third month of gesta-

tion and the beginning of the fourth year—within forty-two months—while the follicles of the permanent teeth require a much longer time for their evolution. It would seem quite reasonable to suppose that the dentinal papilla acts as an organic mold upon which the elements of the enamel are coated, but Magitot asserts that as the epithelial cord which represents the future enamel organ always precedes the appearance of the papilla, which is never formed until the cord has advanced a certain distance, this cord decides not only the *place of genesis*, but the *form* and function of the corresponding tooth. According to Dursy, a dentine germ or papilla may be developed from

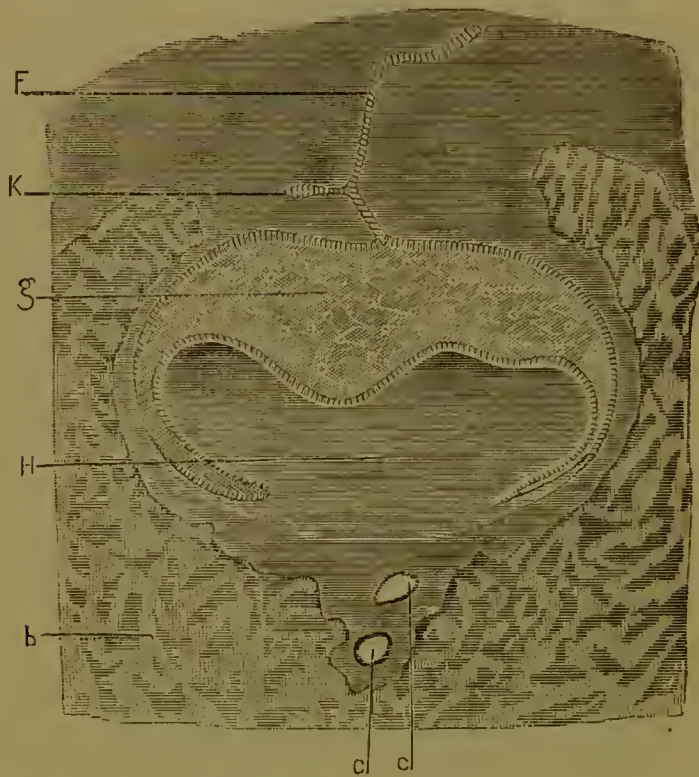


FIG. 95.—SECTION ON A LINE WITH THE FOLLICLE OF THE FIRST PERMANENT MOLAR.

Human subject, three months after birth. (*Magnified 80 diameters.*)

b. Maxillary bone. *c, c.* Dental artery and nerve. *F.* Cord of the follicle of the first permanent molar. *g.* Enamel organ. *H.* Bulb of the first permanent molar. *K.* Bourgeon of the enamel organ of the second permanent molar.

any point of the semilunar area which is found below the enamel organ as soon as such a point is reached by this organ, and the dentine germ depends upon the course which the enamel organ takes. For example, if the epithelial cord of a canine should take an unnatural course, so as to come in contact with the dentinal tissue at a point between the bicuspid, the canine would be developed between those teeth; hence it seems reasonable to conclude that the enamel organ determines the form and character of the future tooth.

Although the proliferations or buddings of the remains of the epi-

thelial cord, after its severance from the enamel organ, usually disappear by absorption, yet it is possible that some such masses, meeting with dentinal tissue, may become the enamel organs of supernumerary teeth.

THE DENTAL PULP.

The pulp, occupying the central cavity in the crown of the tooth, called the *pulp-chamber*, and the *root-canal* in the root of the tooth, is composed of myxomatous connective tissue, in which are distributed blood-vessels and nerves, which enter the apical foramen of the root of the tooth. Near the middle of the root-canal, the small afferent artery, known as the *arteriole*, divides into small vessels,—capillaries,—and forms throughout the pulp-tissue a rich network, which terminates at the periphery of the coronal portion of the pulp in loops. (See Fig. 98.) The capillaries coalesce with a vein, which is a branch of the alveolar vein. Numerous bundles of nerves enter the substance of the

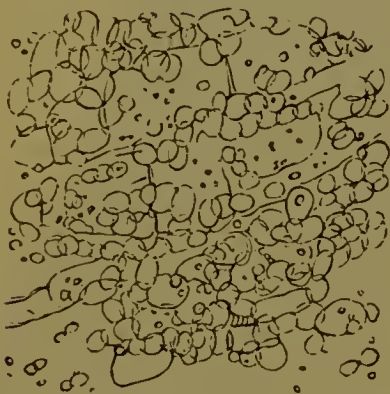


FIG. 96.—A PORTION OF THE BODY OF THE PULP, SHOWING THE CELLULAR ARRANGEMENT.



FIG. 97.—A PORTION OF THE SUPERFICIAL LAYER OF THE PULP, SHOWING THE APPEARANCE OF VESICLES.

pulp through the apical foramen of the root of the tooth, in the form of medullated nerve-fibres, which on approaching the periphery of the organ become non-medullated by the loss of their medullary sheaths, which is characteristic of all nerve-fibres in peripheral organs. During the development of the tooth, the external surface of the pulp is covered by a layer of protoplasmic cells, known as odontoblasts, and of which the fibrillæ of the dentinal tubuli are processes. The pulp of the completed tooth represents the shrunken condition to which the tooth-germ, or dentinal papilla, is permanently reduced after it has normally accomplished the work of dentinification, and affords the vascular and nervous supply of the dentine. In the development of the dentine, the thickening of the dentinal wall is produced by the primary single layer of odontoblasts, and this thickening is not only at the expense of the pulp-cavity, but of the pulp itself, which gradually diminishes in size as the dentine increases in bulk. The dental

pulp is an exquisitely sensitive, highly vascular substance, of a reddish-gray color, enveloped in an exceedingly delicate and apparently structureless membrane, continuous with the peridental membrane, and adherent to the walls of the pulp-cavity. This is designated by Pur-



FIG. 98.

a. The vessels of the pulp of an upper central incisor injected, as seen under the microscope, very highly magnified. *b.* The natural size of the pulp.

kinjé and Raschkow, "the preformative membrane," because, in the formation of the dentine, the deposition of earthy salts, according to these authors, commences in it.

The pulp, according to the two last-mentioned authors, is composed of minute globules. Schwann describes it as consisting of globular, nucleated cells, with vessels and nerves passing between them, the cells having the same radical course as the fibres of the dentine. According to the microscopic observations of Mr. Nasmyth, it is principally composed of minute vesicular cells, varying in size from the ten-thousandth to the one-eighth of an inch in diameter, disposed in concentric layers; these, when macerated, have an irregular, reticulated appearance, and are found to be interspersed with granules, the parenchyma being traversed by vessels having a vertical direction. See Figs. 98 and 99, copied from Mr. Nasmyth.

Mr. Tomes describes it as consisting, from its earliest appearance, of a series of nucleated cells, united and supported by plasma; also, prior to the commencement of the formation of the dentine, of delicate areolar tissue, occupied by a thick, clear, homogeneous fluid or plasma. The pulp is liberally supplied with blood-vessels, furnished by the trunk which enters its base. The ramifications of these vessels are distributed throughout its entire substance, forming a capillary network which terminates in loops upon its surface.

Three or more arteries enter at the apical foramen, and supply the pulp, dividing into branches, which, after pursuing a parallel course, form a capillary plexus immediately beneath the cells of the *membrana eboris*, or ivory membrane. The nerves of the pulp enter the apical foramen by one large and three small trunks, and, like the arteries, pursue at first a parallel course, and about the middle of the root-canal form a rich plexus beneath the *membrana eboris*, or layer of odontoblasts.

The distribution of the vessels of the pulp is represented in Fig. 98, made from an injected preparation of an upper central incisor. The communication of the arteries with the veins by means of a series of looped capillaries, presenting a densely matted appearance upon the surface, is beautifully represented. The nerves of the pulp have a very



FIG. 99.—THE NERVES OF THE PULP OF AN UPPER ADULT BICUSPID, MAGNIFIED TWENTY DIAMETERS.

similar arrangement in their distribution, having apparently looped terminations (Fig. 99).

The dental pulp undergoes considerable change in advanced age, diminishing in size by its progressive calcification.

Further degeneration shows an atrophied condition of the odontoblastic layer, and coincidentally with the diminution in the quantity of the cellular elements, an increase of the fibrillar connective tissue. At last the capillary system becomes obliterated, according to Mr. Charles Tomes, "by the occurrence of thrombosis (effusion of blood into the cellular substance) in the larger vessels, the nerves undergo fatty degeneration, and the pulp becomes a shriveled, unvascular, insensitive mass."

CHAPTER XII.

TOOTH STRUCTURES.

ENAMEL.—With regard to the formation of the enamel, the dental follicles have their origin in a cord which emanates from the epithelial layer of the mucous membrane of the mouth. These cords arise directly from a process of the oral epithelium, those of the permanent teeth, which succeed the deciduous ones, being outgrowths from the primitive cords. Concerning the cords of the other permanent teeth, those for the first molars originate directly from the epithelium of the

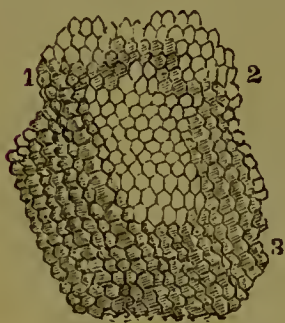


FIG. 100.—THE HEXAGONAL TERMINATION OF THE FIBRES OF A PORTION OF THE SURFACE OF THE ENAMEL; HIGHLY MAGNIFIED.

At 1, 2, 3, the crooked crevices between the hexagonal fibres are more strongly marked.

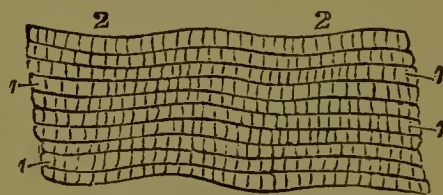


FIG. 101.—A SIDE VIEW OF THE ENAMEL FIBRES; MAGNIFIED 800 TIMES.

1. The enamel fibres. 2, 2. Transverse striæ upon them.

mucous membrane, and the remaining ones from the cords of the preceding molars. The enlarged extremity of the cord constitutes the *enamel organ* of the future dental follicle. (See Origin and Formation of the Teeth.)

When the enamel is first deposited upon the surface of the dentinal papilla, it is of a chalky appearance, and afterward attains the glossy

hardness by which it is characterized, with a white appearance, like porcelain.

The enamel forms a smooth, dense layer enveloping the crown of the tooth as far as the neck, where it insinuates itself between the cementum and dentine. It is thickest on the cutting edges and grinding surfaces of the teeth, tapering to a thin edge at their necks. In color it is rather translucent than white. The analysis of enamel consists of

Calcium Phosphate,	85.3
Calcium Carbonate,	8.0
Calcium Fluorid,	3.2
Magnesium Phosphate,	1.5
Sodium Salts,	1.0
Animal Matter and Water,	1.0

Von Bibra gives the following:—

	<i>Adult Man.</i>	<i>Adult Woman.</i>
Calcium Phosphate and Fluorid,	89.82	81.63
Calcium Carbonate,	4.37	8.88
Magnesium Phosphate,	1.34	2.55
Other salts, . . . . .	.88	.97
Cartilage,	3.39	5.97
Fat, . . . . .	.20	a trace
Organic,	3.59	5.97
Inorganic,	96.41	94.03

Enamel consists of hexagonal or polygonal fibres or rods arranged in waved lines perpendicularly to the dentine. Those fibres or rods, situated on the most prominent part of the crown, are arranged in a vertical direction; those upon the side are placed horizontally, whilst the intermediate fibres present all degrees of obliquity. As these fibres necessarily diverge from the dentinal to their free surface, the upper space thus occasioned must be filled by the gradual enlargement of the fibres from within outward or by the addition of supplemental fibres.



FIG. 102.—HUMAN ENAMEL FROM THE MASTICATING SURFACE OF A MOLAR.

The figure is merely intended to show the general direction of the fibres.

The enamel rods are marked by transverse striæ, which indicate, according to Mr. Beale, the successive layers of calcification, and are

much more strongly pronounced in some specimens than in others, being most markedly so in the enamel of unhealthy subjects.

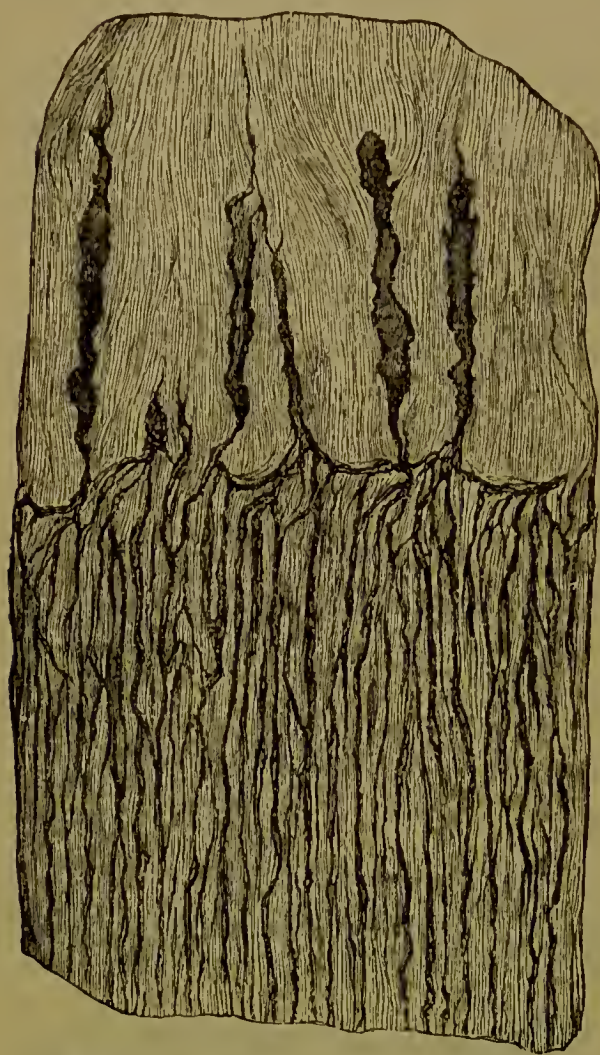


FIG. 103.—CAVITIES IN HUMAN ENAMEL
Which communicate with the dentinal tubes.

Upon opening a dental sac from a fetal jaw, interposed between the inner surface of the sac and the coronal surface of the tooth, a semi-fluid, gelatinous substance will be found, composed of nucleated cylindrical columns with more or less spherical nucleated cells enveloped in fluid. Similar columns will be found on the inner surface of the sac. This is the enamel organ, or enamel pulp, and from it the cells found in the gelatinous fluid have become separated. Columns of a like kind are also found on the surface of the enamel. When the tooth makes its way through the gum, and before it has suffered from friction, by the action of hydrochloric or acetic acid, a membrane-like surface (Nasmyth's membrane) may be raised from

the surface of the enamel; it is soon worn away from the crown of the erupted tooth.

This membrane, to which Mr. Nasmyth first drew attention, has been described as the persistent dental capsule, and consists of a delicate pellicle, exceedingly thin, of a reticulated pattern and of a horny nature, and is indestructible by both acids and alkalies. According to Tomes, Nasmyth's membrane is a thin layer of cementum; according to Kölliker, it is a final product of the enamel cells; according to Waldeyer, it is derived from the external enamel epithelium; according to the latest theory, that of F. T. Paul, it is of an epithelial nature, consisting of a layer of polygonal, flattened epithelium, measuring about 1-2000th inch broad, and up to 1-1000th inch long, placed upon a thin, structureless, elastic membrane, the external enamel

epithelium coming in contact with and adherent to the surface of the enamel.

The enamel differs from dentine in its greater density ; the much earlier period at which entire calcification takes place ; the absence, except in abnormal conditions, of any uncalcified portions ; the direction in which calcification progresses ; and in the fact that it is the least constant of the dental tissues. In pathological conditions irregular cavities are sometimes found in the enamel near to the surface of the dentine, and in such cases the dentine tubes may communicate with them (Fig. 105). In some cases the dentinal tubes may enter the enamel, but this condition is more common to some animals than to the human subject. "It is more frequently absent than present in the teeth of the class of fishes ; it is wanting in the entire order Ophidia among existing reptiles ; and it forms no part of the teeth of the Edentata, and many cetacea among mammals." (Owen's "Odontography," xxiv.) The nutrition of the enamel is yet a mooted question, but that this process is extremely slow is beyond doubt. Sensitiveness of the enamel is denied by R. Baum and others ; but Bödecker* thinks that the simple experiment of eating a sour apple, which in perfectly sound teeth "sets them on edge," is a proof of the sensitiveness of the enamel, and he believes that the pain is due to living matter in normal enamel and the transmission of its contractions to that of the dentine. It is well known that under morbid conditions the enamel may become very sensitive. Dr. Bödecker, therefore, believes in the existence of what he designates as *enamel fibrillæ* in the interstices between the enamel prisms.

DENTINE.—With regard to the manner of the formation of the dentine, the first step in this process is the development of the odontoblasts, which have the same relation in the development of the teeth as osteoblasts have in the formation of bone. The odontoblasts are large nucleated cells, of elongated form, provided with numerous processes developed from the dentinal papilla, which at that early stage consists of fine fibrous tissue containing many cells. The odontoblasts send out processes, which, as they develop, become calcified externally, the calcified portion forming the dentine, and the uncalcified part the dentinal fibrillæ, and the lateral processes the branches of anastomosis through which the tubuli or canals of the dentine communicate.

The remains of the odontoblasts themselves form the investment of the pulp, situated between its nerves and vessels and the dentine, a cellular layer known as the *membrana eboris*, or ivory membrane of

* "Anatomy and Pathology of the Teeth."

Kölliker. (See Origin and Formation of the Teeth.) The dentine is deposited around the fibrils of the odontoblasts, the latter occupying a position nearly at right angles to the surface of the dentine, the deposition being in the protoplasm which is found in interspaces between the fibres. Lime salts being deposited in the protoplasmic basis substance, the odontoblast, as the process of secretion proceeds, becomes enclosed in a thin spherule of formed material, known as "calcoglobulin,"* and the dentine substance or tissue assumes the form of a homogeneous mass, traversed by tubes which contain the dentinal fibrils.

The greater portion or body of every tooth is composed of dentine, which is a yellowish-white, semi-transparent, hard, elastic substance, and intermediate in consistence between the enamel and the cementum. In a normal condition the dentine is never exposed, being covered in the crown of the tooth by the enamel, and in the root by the cementum.

In a fresh specimen the human tooth is found to consist of 62 per cent. of its weight in organic salts, 28 per cent. of tooth cartilage (organic matter), and 10 per cent. of water.

Berzelius gives the following analysis of dentine :—

Calcium Phosphate,	62.00
Calcium Carbonate,	5.50
Calcium Fluorid,	2.00
Magnesium Phosphate,	1.00
Sodium Salts,	1.50
Gelatin and Water,	28.00

Von Bibra gives—

Calcium Phosphate and Fluorid,	67.54
Calcium Carbonate,	7.97
Magnesium Phosphate,	2.49
Salts,	1.00
Fat, . . . . .	.58
Cartilage,	20.42

While the organic basis of the matrix of dentine is similar to that of bone, yet it is not identical, being of firmer consistence, and does not yield gelatin when boiled. A fresh section of dentine presents a satiny aspect, but when submitted to the microscope it is found to consist of a multitude of fine tubes, known as the *dentinal tubuli*,

* Calcoglobulin is a term applied to a thin layer of partially calcified tissue, found between the organic and inorganic tissue in the development of bone, dentine, and cementum.

with an *intertubular substance*. These minute tubes permeate the entire structure of the dentine, their direction varying in the different parts of the tooth. Each tube originates by an open, circular mouth or orifice upon the surface of the pulp-cavity, where it runs toward the periphery of the dentine in a direction usually perpendicular to the surface, just before reaching which it divides into branches.

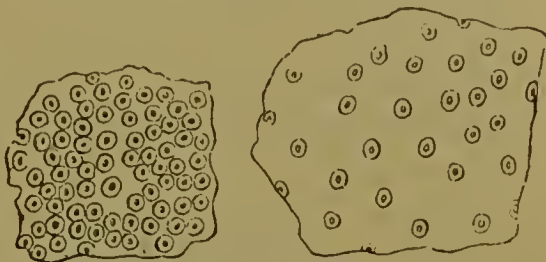


FIG. 104.—TRANSVERSE SECTION OF DENTINE.

Proceeding in a wavy and radiated manner throughout every portion of the dentine to its periphery, these tubes, although generally terminating at that point, in some instances extend beyond and encroach upon the enamel or upon the cementum. When the latter is the case, they may communicate with the canaliculi and lacunæ.

Toward the grinding surface of the crown of a tooth, when occlusion is received, these tubes have a vertical direction, and a horizontal

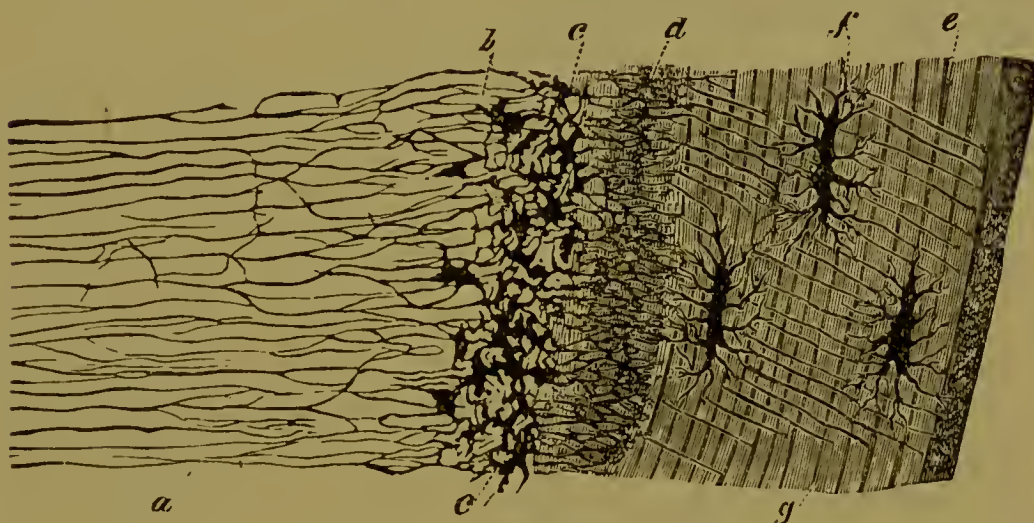


FIG. 105.—DENTINE AND CEMENTUM FROM THE ROOT OF A HUMAN INCISOR; COPIED FROM KÖLLIKER.

a. Dentine fibres or tubes. *b.* Interglobular spaces, having the appearance of the *lacunæ* in bone. *c.* Smaller interglobular spaces. *d.* Commencement of the cementum, with numerous canals close together. *e.* Its *lamellæ*. *f.* *Lacunæ*. *g.* Canals.

direction when the pressure of adjoining teeth has to be resisted ; and thus the shock of occlusion and pressure is more generally distributed over the entire tooth structure. These dentinal tubes, instead of pursuing a straight course, describe curves, the longer ones less abruptly defined than the others, and are termed “primary curvatures,” the latter being more common to the crown than to the root. The secondary curvatures, although smaller than the primary, are much more numerous. The coincidence of the primary curvatures of adjoining dentinal tubes, or the presence of rows of what are known as “interglobular spaces” (Fig. 105), may occasion a striated or laminated ap-

pearance of the dentine, the lines thus formed being at nearly right angles with the tubes and known as the *contour* lines of Owen. They proceed in an arched manner, somewhat parallel to each other.

The dentinal tubes are cemented together by a sub-granular matter, radiating from the cavity to the surface of the tooth. From these tubes branches are given off in great number in the roots and as the enamel approaches the dentinal surface. In the crown these branches are few in number. They anastomose freely with each other and with the superficial dental tissues. They terminate in loops or are lost in the enamel. By their extension into the superficial dental tissues a close union is formed between them and the dentine, notwithstanding the fact that each tissue is developed from a distinct formative pulp. Kölliker thought these tubes contained clear fluid in the fresh state. In the dried preparation they are empty, and are readily permeated by colored fluid. These facts give rise to the opinion that their sole

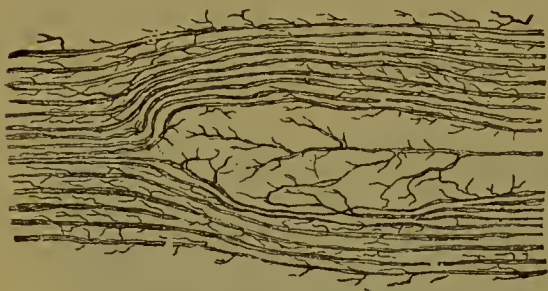


FIG. 106.—TERMINATION OF A DENTINAL TUBE IN THE MIDST OF THE DENTINE—HUMAN.

purpose was the conduct of nutrient fluids. Mr. Tomes, however, following Nasmyth, objected to this theory on purely physiological grounds. The extreme sensitiveness of an exposed coronal surface from which a portion of enamel has been broken; the fact that in operations for the removal of

carious dentine the sensitiveness was found to be greatest just beneath the enamel; and furthermore, that when the pulp was broken up or destroyed by escharotics, this sensibility was lost, led him to conclude that the sensibility of the dentine depended on its connection with the pulp, and to suppose that these tube-contents might be in some way associated with the sensibility of the structure in which they were found, serving to establish connection between it and the pulps, to which supposition fluid contents opposed an insurmountable difficulty. Led by this train of reasoning to a careful examination of the tubes, he found each dentinal tube tenanted by a soft fibril, which, after passing from the pulp into the tube, follows its ramifications, and that these fibrils may be traced into the substance of the pulp. Kölliker and Lent were the first to determine the connection of these fibrils with the odontoblasts of the pulp.



FIG. 107.—A FRAGMENT OF DENTINE.

a. Through which run the softer fibrils, c, which seem to be continuous with the odontoblast cells, b. (After Dr. Lionel Beale.)

Mr. Tomes says: "It is by no means necessary to assume that the dentinal fibrils are actually nerves before allowing them the power of communicating sensation. Many animals are endowed with sensation which yet possess no demonstrable nervous system;" whilst, at the same time, it has been impossible to demonstrate nerves in the human body so numerous as to warrant the assumption that at every prick of a needle the point must touch a nerve fibre. Again, the greater sensibility of the dentine immediately beneath the enamel is satisfactorily accounted for by the law which refers to all nerves the greatest sensibility at their terminal extremities. He also thinks "the foregoing facts will warrant the conclusion that the dentinal fibrils are subservient to sensation in the dentine, since, when their connection with the pulp is cut off, all sensibility is lost to the dentine."

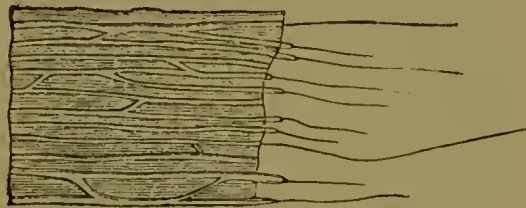


FIG. 108.—SECTION OF DENTINE.
From the edge of which hang out the dentinal sheaths, and beyond these again the fibrils.
(After Boll.)

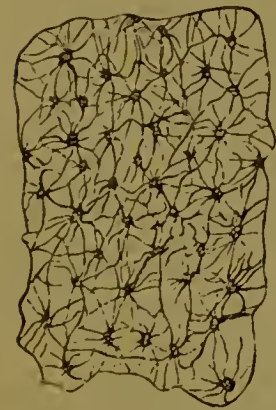


FIG. 109.—TRANSVERSE SECTION THROUGH THE DENTINAL TUBULI OF THE ROOT OF A HUMAN TOOTH.

Magnified 350 diameters, showing their numerous anastomoses.

Dr. Bödecker,* on the other hand, claims that he has demonstrated by careful investigations that the dentinal fibrillæ are not nerves, but formations of living matter, and gives the following reasons for this opinion: "First, that it is impossible to admit of a connective tissue holding nerves alone in its constituent soft parts. Second, neither have we, nor has G. Retzius, been able to trace a direct inosculation of the dentinal fibrillæ with the axis-fibrillæ of the nerves so abundantly distributed throughout the periphery of the pulp-tissue." And he further says that as soon as we admit that the dentinal fibrillæ are formations of living matter, the same as are the nerves, all difficulties vanish in explaining the transmission of sensation from the periphery of the dentine to the nerve of the pulp-tissue. Living matter is, according to Heitzmann, contractile matter. Nerves are made of living matter, and owing to their reticulated or beaded structure, are fittest for that transmission of contractions from the periphery to the nervous centres which we call sensation. Contraction of the dentinal fibres transmitted into the reticulum of the protoplasm at the periphery of the pulp, and thence into the ultimate nerve fibrillæ,—all of which formatives are proven to be con-

* "Anatomy and Pathology of the Teeth."

tinuous,—are sufficient to explain the transmission of sensation, or, speaking bluntly, of pain.”

The dentinal fibrillæ appear to be formed by the peripheral portions of the processes of the odontoblasts, after the latter become long and narrow, attaining considerable length.

The formation of dentine begins about the fourth month of fetal life, at the summit of the papilla. The superficial portion of the crown is first formed, and afterward undergoes no alteration in size, all subsequent growth taking place on the surface adjacent to the dentinal pulp. The growth of the root takes place from above, downward into the alveolus destined to receive it. Placed at right angles to the outer surface of the pulp, between it and the dentine already formed, or before any dentine is formed, is situated a layer of “elongated cylindrical bodies of cells, with nuclei” somewhat resembling nucleated, columnar epithelium. With regard to the exact share taken by the pulp in the formation of dentine, Kölliker says a layer of cells forming the peripheral portion of the pulp are immediately concerned in its formation. He does not consider that the “same cell suffices for the whole duration of the dentine,” but that new cells may from time to time be formed; and denies that the whole pulp is progressively changed into dentinal cells, and thinks its only purpose is to support the vessels essential to the growth of the dentinal cells, from which alone the dentine is formed, by the gradual

reception of calcareous salts. (From “Tomes’s Dental Surgery,” 388.)

Prof. Christopher Johnson, of Baltimore, succeeded in tracing communication between the fibrillæ of the dentine and the odontoblasts of the pulp—and to it we must refer the sensibility of this tissue.

On account of the tubes dividing into minute branches, as they approach the surface of the dentine, they appear to end in very fine-pointed extremities. Some of these tubes anastomose with the branches of others, forming loops near the periphery, while others terminate deeper in the tissue. The inner



FIG. 110.—INTERGLOBULAR SPACES IN DENTINE.

walls of the tubes surrounding the fibrillæ constitute the dentinal sheaths, which are apparently of fibrous structure.

The *intertubular tissue* contains the greater part of the earthy

constituents of the dentine, and under the microscope presents a granular appearance.

What are known as *interglobular spaces* are indicators of arrested development of the dentinal tissue, and are not considered to be normal. These spaces are dark and irregular, and are most commonly observed a little distance below the surface in a discolored and imperfectly developed tooth; they have a ragged outline. According to Bödecker, soft, living plasm is found in the smaller interglobular spaces.

According to Krause, dentine has a specific gravity of 2.080, and contains less earthy matter than the enamel, but more animal substance, which accounts for the rapid progress of caries when the dentine is exposed.

CEMENTUM.—Cementum is developed from the deeper tissues of the fetal jaw, precisely like bone is produced in other parts of the body, by periosteal ossification, and is modified bone-tissue peculiar to the structure of the teeth. It contains canaliculi and lacunæ, and, according to Salter, Haversian canals in the thicker portion.

It is not so dense as the dentine, and approaches more nearly in character true bone, which is necessary in order that the tooth may be tolerated by the more highly vitalized structures in relation with it.

The analysis of cementum is as follows:—

Calcium Phosphate and Fluorid,	58.73
Calcium Carbonate,	7.22
Magnesium Phosphate,	0.99
Salts,	0.82
Cartilage,	31.31
Fat,	0.93

The Cementum, or *Crusta Petrosa*, is the most highly organized of the dental structures. Generally the cementum is covered on its external periphery by a layer of calcified protoplasmic cells similar to bone-cells, *osteoblasts*, which are in connection with the fibrous connective tissue of the peridental membrane. At the neck of the tooth



FIG. 111.—THICK LAMINATED CEMENTUM.
From the root of a human tooth.

it is composed of calcified basis-substance, penetrated by spindle-shaped protoplasmic cells. In the root portion there is a distinct lamellation, where are presented the *cement-corpuscles*, which closely resemble bone-corpuscles. Cementum covers the roots of all the teeth,



FIG. 112.—LACUNA OF CEMENTUM,
Which communicates with the termination of the dentinal tubes.

encroaching slightly upon the crown, where it overlaps the enamel. Its purpose is to bind the teeth securely in the alveoli, forming the vital bond between the bone and the commonly unvascular constituents of the teeth. It is thickest about the terminal part of the root, gradually thinning as it approaches the crown. In the thicker parts the canaliculi are seen anastomosing freely with each other, and establishing vascular relations between the several lacunæ; and they occasionally

become connected with the terminal branches of the dental tubuli. Haversian canals, as was before remarked, are also found in very thick sections of cementum. The lacunæ and canaliculi of cementum are distributed lengthwise around the root, those in proximity to the dentine joining with the terminal branches of the dentinal tubuli, while those upon the external surface radiate toward the investing membrane.

By such a provision, even after the devitalization and removal of the pulp, the vitality of the cementum of the teeth is maintained.

From irritation of the peridental membrane the cementum often becomes hypertrophied, the affection being known as “hypercementosis.” Cementum contains more animal matter than the dentine, and becomes very sensitive when exposed by the recession of the gum about the neck of the tooth.

OSTEO-DENTINE.—Osteo- or secondary dentine is a substance partaking more of the nature of cementum than of ordinary dentine, as it possesses no true dentinal tubes, but canals similar to the canaliculi of bone. It is generally formed in the teeth of persons of advanced age, where the pulp-cavity is very much diminished in size, and it also forms a protection against the exposure of the pulp of the tooth which has been denuded of its natural tissues by mechanical abrasion, the action of caries, or by fracture. In other cases secondary dentine is deposited in isolated nodules scattered throughout the substance of the dental pulp, which may unite and form larger masses and become adherent to the walls of the pulp-cavity. Some of these masses are occasionally penetrated by blood-vessels and surrounded by concentric lamellæ, like the Haversian canals of bone.

The dividing line between the primitive and secondary formations of dentine is characterized by numerous irregular spaces and globular contours, while deeper in the mass of lately formed secondary dentine tubes or canals may exist.

Not infrequently, however, the tubuli of secondary dentine are arranged in a very irregular manner, either "in tufts or in bundles, and without any apparent reference to points of radiation." Osteodentine is also usually very transparent, on account of this tissue being devoid of light-refracting tubes, its canals being so completely filled up with the secondary deposit that they permit the transmission of light. The



FIG. 113.—SECONDARY DENTINE,
Filling up one of the cornua of the pulp-cavity.
From a human molar affected by caries.

tubuli of normal dentine are frequently filled with a secondary deposit, especially in the roots of teeth, and to which the name "horny dentine" has been given. The formation of secondary dentine appears to depend upon irritation of the pulp, of long continuance but restricted as to degree, and during the time "that the slow conversion of the organ is taking place the dentinal fibrillæ also become impregnated with calcareous matter and solidify."

PART SECOND.

DENTAL PATHOLOGY, THERAPEUTICS.

CHAPTER I.

THE TEMPERAMENTS IN RELATION TO THE TEETH.

THE individual conditions or qualities known as temperaments exercise an influence upon the teeth, as well as upon the other functional operations of the body. The word temperament is derived from the Latin *tempero*, "to mix together," and implies the constitution as determined by the predominance of certain constituents of the body. For among the ancients it was supposed that the manifestations of the functions were tempered or so determined by the predominance of any one of the three humors then recognized, namely: blood, lymph, bile, and atrabilis, or black bile. Dunglison, in his Medical Dictionary, defines the temperaments to be those individual differences which consist in "such disproportion of parts, as regards volume and activity, as to sensibly modify the whole organism, but without interfering with the health;" in other words, a physiological condition in which the functions of the different organs are so regulated as to impress certain characteristics upon each individual. Others contend that these individual differences, "though they can scarcely be called morbid, yet certainly give a proclivity to disease in the direction indicated by the temperaments."

Dr. James W. White, on this subject, remarks: "Temperament may be defined as a constitutional organization, depending primarily upon heredity—national or ancestral—and consisting chiefly in a certain relative proportion of the mechanical, nutritive, and nervous systems, and the relative energy of the various functions of the body—the reciprocal action of the digestive, respiratory, circulatory, and nervous systems. The stomach, liver, lungs, heart, and brain—digestion, assimilation, respiration, circulation, and innervation—are all factors in the differentiation of temperament; and according to the congenital predominance of one or the other, and the relative activity of these functions, is the modification of the characteristics of the individual which determines his position as to temperament. Each temperament is the result as well as the indication of the preponderance of one or another of these systems, and of relative functional activity.

"A perfect equilibrium of the different systems is rarely if ever presented in any individual. One having a balance of all the temperaments would be temperamentless, or of no special temperament. It is difficult, in some cases, to decide positively to which variety a special case belongs, the several temperaments being combined and blended in such ever-varying proportions. Not infrequently the indications

are even contradictory, and the blending of several temperaments requires a nice discrimination to define the admixture. The primary elements of temperament are susceptible of such manifold combinations; the determining forces are so complex, and our knowledge of their comparative values is so limited, that no rule can be given which will not fail in numerous instances to apply in all respects to individual cases; but that there is a general relation between constitutional qualities and external signs does not admit of question.

“Temperaments are readily divisible into four basal classes—bilious, sanguineous, nervous, and lymphatic; then again into sub-classes of mixed temperaments—a combination of two or more of the primary divisions. In these combinations one or other of the so-called basal temperaments predominates, and a compound term is used to express the complexity, as, for instance, the nervo-bilious, signifying that the bilious base—the foundation temperament—is qualified by an admixture of the nervous element, and so throughout the series. Twelve varieties of temperament, in addition to the four basal, may thus be designated by the combination in pairs of the original four. The admixture of the peculiarities of three or of all four of the basal temperaments results in what are denominated respectively ternary and quaternary combinations, which call for nice discrimination in diagnosis; but even such complexities are registered in the size, form, and color of the dental organs.”

The *sanguineous* temperament is characterized by a fair, ruddy complexion, yellow, red or light auburn, or light-brown hair, a good class of teeth, a full muscular development, large, full veins and active pulse, indicating an abundant supply of blood, and warm extremities, all showing perfect health, and in females a tendency to voluptuousness. The mind is hopeful and elastic, yet at the same time fickle and volatile, with little determination and perseverance. Although indicating perfect health, yet in this temperament diseases are prone to assume the acute form, and speedily run their course either to recovery or a fatal termination.

The *bilious* temperament is characterized by a preponderance of bile, indicated by a dark or sallow countenance, black hair, generally luxuriant, a slow or moderate circulation of the blood, shown by a hard, strong pulse, dark eyes, strong teeth, with a yellow tinge over the entire crown; and the body, instead of the roundness of form peculiar to the sanguine temperament, is angular; wanting in ease and grace of manner; there is restlessness, but at the same time great force of character and quickness of perception and power of will. The digestive organs, however, are more liable to derangement than in other temperaments, indicating some defective action

in these organs; the liver, of course, being the principal one affected, and necessitating the use of mercury as a stimulus.

The *lymphatic* temperament is characterized by a predominance of lymph or phlegm in the system; and persons possessing it have a general softness or laxity of the tissues, the proportion of the fluids being too great for that of the solids, the lymphatics and absorbents not acting so thoroughly as to prevent the cellular tissue from being filled with humors; so that there is a want of sensibility. The complexion is fair, but not ruddy, and the hair, either light or dark, is not luxuriant, but thin and straight. The eyes are light, generally blue, the circulation feeble, and the pulse, as a consequence, weak, and a want of tone in the system. The skin is pale, flabby, and moist, and the body is heavy and rounded, while the teeth, although they may often appear comparatively good, yet are sensitive and not highly organized. Although the expression denotes a want of activity, yet there is a clear and active mind, characterized by prudence and sound judgment without enthusiasm. Owing to the predominance of lymph, there is a tendency to dropsy and chronic disease.

The *nervous* temperament is characterized by the predominance of the nervous element, and by great activity or susceptibility of the great nervous center—the brain. Persons possessing this temperament are distinguished by their impressibility, susceptibility to intense feeling or intense excitement. There is great irritability, anxiety, and agitation, which peculiarities enable us readily to recognize it by the tone of voice and manner of speaking. The body is slender, though well formed, the complexion pale and soft, and the muscles small and yielding. In illness, symptoms are often complicated with those of nervous disorder, and the mind desponding. There is want of power and endurance.

Upon the temperament the constitutional health depends to a greater extent than pathologists generally admit; and hence it is that that of the child usually partakes of that of one or other, or both, of its parents. “This,” says M. Delabarre, “is particularly observable in subjects that have been suckled by a mother or nurse whose temperament was similar to theirs.” To obviate the entailment of this evil, he recommends mothers having teeth constitutionally bad to abstain from suckling, and that this highly important office be intrusted to a nurse having good teeth; asserting at the same time, that by this means the transmission of so troublesome a heritage as bad teeth may be avoided.

Dr. J. Foster Flagg gives the following tabular presentations of the relation of the temperament to the teeth:—

THE TEETH AS INDICATED BY TEMPERAMENT.

GENERAL DIVISIONS.	BILIOUS.	SANGUINEOUS.	NERVOUS.	LYMPHATIC.
General Color and Quality of Color,	Bronze-yellow, with strength or power of coloring.	Cream-yellow, and inclined to translucency.	Pearl-blue or gray; inclined to transparency.	Pallid and opaque, or muddy in coloring.
General Form,	Large and inclined to angular; rather long in proportion to breadth.	Well proportioned; abounding in curved or rounded outlines; cusps rounding.	Length predominating over breadth; fine, long, cutting edges and cusps.	Large, but not shapely; breadth predominating over length; cusps poorly defined.
Surfaces of the Teeth, . . .	Inclined to transverse ridges, and abounding in strong lines; neither brilliancy nor transparency of surface, but slight translucency.	Smooth, or nearly so; elevations and depressions rounded; cutting edges and cusps translucent. Fair degree of brilliancy.	Brilliant and transparent depressions and elevations; abounding in long curves.	Surface of incisors devoid of depressions or elevations; opaque and dead in finish, even to cutting edges.
Articulation,	Firm and close; well locked.	Moderately firm; jaw inclined to rotate in mastication.	Very long and penetrating.	Loose and flat.
Gum Margin or Festoon, . .	Heavy and firm, but inclined to angularity.	Round and full, as regards both breadth and depth.	Delicate, shapely, and fine; oval in curve.	Thick and undefined in shape.
Rugæ,	Heavy and rugged in shape; squarely set.	Numerous and graceful in outline; not heavy, but well rounded.	Close, not numerous; small and long.	Sparse and flat.

CHARACTERISTICS OF THE TEETH.

Most dental physiologists have observed the marked differences that exist in the appearances of the teeth, gums, lips, tongue, and secretions of the mouth of different individuals; and of that earthy substance (commonly called tartar), deposited in a greater or less abundance on the teeth of every one; and, although all may not have sought their etiology, many have had occasion to notice, at least, their local indications, and to profit by the information which they have thus obtained. Nor have they failed to observe that the size, color, length, and arrangement of the teeth vary, and that these are indications of their susceptibility to disease.

There are five principal classes or descriptions of teeth, each of which differs, in some respects, from the others, a knowledge of which is very essential to the dental practitioner, in order that he may determine their liability to decay, strength of attachment, and the form and size of their roots.

Class First.—The teeth belonging to this class are white, with a light cream-colored tinge near the gum, which becomes more and more apparent as the subject advances in age, of a medium size, rather short than long, with thick, square edges; those of each class of uniform dimensions, and very hard. This description of the teeth is most frequently met with in persons of sanguineous temperament, or, at least, those in whom this predominates; they rarely decay, and generally occupy their proper position in the dental arch; the most common deviation, and one most peculiar to this class, is that of the superior incisors antagonizing with the inferior, causing the form of abrasion known as mechanical. They are not as easily acted upon by corrosive agents, and caries attacking them, usually of the black variety, makes but slow progress, and often exists for a considerable time without causing pain or inconvenience. Operations performed upon teeth of this class are those, above all others, on which we can predict the most perfect success. They indicate, if not *perfect* health, at least a state which bordered very closely on it at the time of their dentinification.

This first description of teeth is occasionally found among persons of all nations. They are very common in cold and temperate climates, and those who have them usually enjoy excellent health.

In confirmation of what has before been said with regard to the influence which the state of the constitutional health at the time of the solidification of the teeth exerts upon the susceptibility of these organs to morbid impressions, it is only necessary to mention the fact, well known and frequently alluded to, of the early decay of a single

class, or a pair of a single class of teeth, in each jaw, while the rest, possessing the characteristics just described, remain sound through life. Thus, when it happens that a child of excellent constitution is affected with any severe disease, the teeth which are at the time receiving their earthy salts are found, on their eruption, to differ from those which have received their solid material at another time, when the operations of the body were healthfully performed. Instead of having a white, smooth, and uniform surface, they have a sort of chalky aspect, or are faintly tinged with blue, and are rougher and less uniform in their surfaces. Teeth of this description are very susceptible to the action of corrosive agents, and, as a consequence, rarely last long.

Class Second.—Having digressed thus far, we shall now proceed to notice the teeth belonging to the second class. They have a faint, azure-blue appearance; are rather long than short; the incisors are generally thin and narrow, the centrals being frequently a little longer than the laterals. In some cases the lateral incisors are very small and pointed. The cuspids are usually round and pointed; the bicuspid and molars small in circumference, with prominent cusps and protuberances upon their grinding surfaces.

Teeth possessing these characteristics are usually very sensitive, caused, doubtless, by a superabundance of animal matter, and are more easily acted upon than teeth of the first class by corrosive agents, and to the ravages of which, unless great attention is paid to their cleanliness, they often fall early victims. The variety of caries almost peculiar to this class is known as the white, the parts attacked being rendered soft and humid; and as they retain their natural color, it but too frequently happens that such teeth are almost irretrievably ruined before its presence is suspected. They are, also, more frequently affected with atrophy, or have upon their surfaces white, brown, or opaque spots, varying in size and number; several are sometimes found upon a single tooth, and in some instances every tooth in the mouth is more or less marked with them.

But this is not the only description of teeth liable to be affected with this disease. These spots are occasionally met with on teeth of every degree of density, shape, shade, and size; but they are, probably, more frequently seen on teeth of the second class than on those first described; besides which, it often happens that they are affected with erosion on emerging from the gums, and sometimes so badly as to place either their restoration or preservation beyond the reach of art. This species of erosion, or that which occurs previously to the eruption of the teeth, is caused by some diseased condition of the fluid which surrounds them before they appear above the gums, and is denominated congenital.

Teeth like those now under consideration are indicative of a weakly constitution, of a temperament considerably removed from the sanguineous, resembling the lymphatic, and of blood altogether too serous to furnish materials such as are necessary for building up a strong and healthy organism. They are more common to females than to males, though many of the latter have them. They are met with among people of all countries, but more frequently among those who reside in sickly localities, and with individuals whose systems have become enervated by luxurious living.

Class Third.—The teeth of this class, though differing in many of their characteristics from those last described, are, nevertheless, not unlike them in texture and sensibility to disease. They are peculiar to those who have inherited a scrofulous habit or diathesis. In this state of the system we find a sufficient supply of blood, but it is usually of a pernicious character; the whole organism is affected by it and rendered very susceptible to disease, more especially to that class superinduced by cold. Teeth developed under constitutional defects of this nature are larger than teeth of the first or second class; their faces are rough and irregular, with protuberances arising, not only from the grinding surfaces of the bicuspid and molars, but also not unfrequently from their sides, with correspondingly deep indentations. They have a muddy white color. The crowns of the incisors of both jaws are broad, long, and thick. The posterior or palatine surfaces of those of the superior maxilla are rough and usually deeply indented. In the majority of cases their arrangement is quite regular, though frequently found to project. The alveolar ridge usually describes a broad arch. The excess in size, both here and in the teeth, seems to consist more of gelatin than calcareous phosphate. Teeth of this description decay rapidly, and in some instances appear to set at defiance the resources of the dentist. They are liable to be attacked at almost every point, but more particularly in their indentations and approximal surfaces. The caries to which these teeth are liable is in color and consistence between the two kinds mentioned in connection with the first and second classes.

The corrosive properties of the fluids of the mouth, however, are sometimes so changed by an amelioration of the constitution that, notwithstanding the great susceptibility of the teeth to disease, they are sometimes preserved to a late period of life, or until the general health relapses into its former or some other unfavorable condition. This has happened in several instances that have come under the author's immediate observation, and it should be borne in mind that the solvent qualities of these secretions are influenced by the state of the constitutional health.

Class Fourth.—Teeth of this class usually have a white, chalky appearance, are unequally developed, and of a very soft texture. They are easily acted upon by corrosive agents, and, like the teeth last noticed, generally fall speedy victims to disease, unless great care is taken to secure their preservation.

Persons who have teeth such as described in this class, generally have what Laforgue has called *lymphatico-serous* temperaments. Their blood is usually pale, the fluids of the mouth abundant, and for the most part exceedingly viscid. They do not have that white, frothy appearance observable in healthy, sanguineous individuals.

As teeth that are neither too large nor too small, and that have a close, compact texture, and tinged with yellow, are indicative of an originally good constitution, whatever it may be at the present time, so those that are long, narrow, and faintly tinged with blue, as well as those that greatly exceed the ordinary size, and that are irregular in shape, and have a rough, muddy appearance, furnish assurance of a constitution originally bad. The first of the latter descriptions of teeth are more frequently met with among females than males, and among those of strumous habit, than those in whom this diathesis does not exist.

Class Fifth.—The teeth belonging to this class are characterized by whiteness and a pearly gloss of the enamel. They are long and usually small in circumference, though sometimes well developed. They are regarded by many as denoting a tendency to phthisis pulmonalis, and are supposed by some to be very durable; but the author has observed that individuals who have this sort of teeth, when attacked by febrile or any other form of disease having a tendency to alter the fluids of the body, are very subject to toothache and caries; and that when this condition of the general system is continued for a considerable length of time, the teeth, one after another, in rapid succession, crumble to pieces.

It would seem, from this circumstance, that the fluids of the mouth in subjects of strumous habit, if free from other morbid tendencies, are less prejudicial to the teeth than they are in most other constitutions, and the author is of the opinion that it is owing to this that they are so seldom attacked by caries.

There are other cases in which the teeth are of so inferior a quality that they no sooner emerge from the gums than they are attacked and destroyed by caries, while the subjects who possess them are enabled, by skillful treatment, to overcome the morbid constitutional tendencies against which, during the earlier years of their existence, they had to contend, and eventually to acquire excellent health. But in forming a prognosis, it is essential to ascertain whether the general

organic derangement which prevented the teeth from being well formed, and thus gave rise to their premature decay, is hereditary, or whether it has been produced by some accidental cause subsequent to birth. The procurement of health in the former case will be less certain than in the latter, for when the original elements of the organism are bad, the attainment of a good constitution is more difficult.

Persons of sanguineo-mucous temperaments, having suffered in early childhood from febrile or inflammatory diseases, often have their teeth affected with what Duval calls the decortivating process (denudation of their enamel), resulting, no doubt, from the destruction of the bond of union between it and the dentine.

There are other characteristics which the teeth present in shape, size, density, and color, and from which valuable inductions might be made, both with regard to the innate constitution and the means necessary to their own preservation; but as the limits assigned to this part of our subject will not admit of their consideration, we shall conclude by observing that the appearances of these organs vary almost to infinity. Each is indicative of the state of the general health at the time of their formation, and of their own physical condition and susceptibility to disease.

CHAPTER II.

DENTITION.

THE term "dentition" implies the eruption of the teeth, and is a process which consists of two stages, namely, first dentition and second dentition. At about the seventh week of intra-uterine existence the process of development of the teeth of first dentition begins, and shortly after birth the outlines of the forms of the deciduous teeth may be observed on the external aspect of the jaws; but as age advances, owing to the increased development of the mucous membrane and alveolar processes, these outlines become less apparent. As the period of dentition approaches, a slight ridge on the summit of each jaw is seen, which is attributed to the dipping down of the process of epithelium which forms the enamel organ. Prior to the sixth month of age (first dentition commencing generally between the fifth and seventh months after birth), small prominences are observed on the summits of the alveolar processes, which gradually become more distinct and almost as light in color as the teeth themselves. As soon as the tooth has penetrated the mucous membrane, the latter contracts so as to permit the crown of the tooth to project above its level.

The deciduous teeth begin to erupt between the fifth and seventh months, and at the age of two years and a half all of the first set have appeared, the corresponding teeth of the two sides of the jaw erupting at the same time. The two inferior central incisors appear at the age of six or seven months, in the order in which they are named, followed by the superior central incisors, the superior lateral incisors, the inferior lateral incisors, the four first molars, the four canines, and last, the four second molars. The usual order of the eruption of the deciduous teeth is as follows :—

Central incisors	between the	5th and	8th months.
Lateral incisors	“ “	7th and 10th	“
First molars	“ “	12th and 16th	“
Cuspids	“ “	14th and 20th	“
Second molars	“ “	20th and 30th	“

The lower teeth generally precede the upper teeth by a few weeks, appearing in the same order.

This order, however, is not invariably followed, for teeth may be prematurely erupted so as to be seen at birth. But the cases of retarded eruption are much more common than those of premature eruption, owing to constitutional debility or the existence of some constitutional disease.

During the eruptive period there is a gradual elongation and protrusion of the teeth, and a coincident dissolving away of both the hard and soft tissues which overlie them. The approximal edges of the alveolar borders of the maxillary bones disappear by an absorptive process, the teeth rise in their cavities, and their roots lengthen to such a degree that the crowns press upon the opposing gums, which, under such pressure, become thinner and thinner, until finally the crowns escape.

Henry Sewell, M.R.C.S., gives the following concise description of the process of eruption: “The eruption of the teeth is a process of gradual elongation of the teeth on the one hand, and the simultaneous absorption of the super-imposed tissue on the other. The absorption commences, first, in the overhanging margins and front walls of the alveoli, which gradually disappear until room is afforded for the passage of the advancing tooth. The growth of the tooth keeps pace with this absorption, and the crown of the tooth at length pressing against the membranous coverings, these undergo atrophy, and becoming by degrees thinner, and at last transparent, give way and disclose the advancing crown.”

The exact relation of dentition to infantile diseases is not generally recognized, and many affections have been erroneously ascribed to this process.

There is no doubt, however, that the condition of the system at the period of first dentition is such that the infant is very susceptible to nervous impressions, and hence the symptoms of any constitutional disease that may be present are greatly aggravated.

Owing to the predominance of the nervous system in infancy, there is a greater sympathy between distant organs than in adult life, and considerable disturbances may be excited early in life by even slight functional disorders. The brain is proportionally larger and less perfect in structure than in the adult; the tissues of the body are also softer and more vascular, the skin is more sensitive, the abdomen, glands, kidneys, liver, pancreas, and lacteal vessels are disproportionately large, and functional activity depends chiefly upon the nutritive processes. Such peculiarities, therefore, account for the susceptibility to disease in infants and the tendency of their disease to become inflammatory, and to involve organs not originally affected.

The evolution of the teeth is commonly attended with more or less inflammation of the parts in relation with the dental follicles, and this turgescence is greater with some teeth than with others; sometimes it is present to such a degree that the gums are greatly swollen and extremely tender, presenting a very red appearance, more so than in ordinary dentition.

The indications of the eruption of the teeth are an increased flow of saliva, which tends to keep the mouth moist and cool, and is due to the irritation of the trifacial nerve, which gives sensation to the teeth and nutrition to the salivary glands; an itching of the mouth, which causes the infant to keep its fingers on the gums, as a slight pressure evidently gives some relief; the irritation continuing, the mouth, as a result, becomes hot and dry, and there is more or less febrile excitement. Diarrhea frequently ensues, which, if not too great, is beneficial; one or both cheeks may become unusually red, which is a symptom of nervous disturbance; eruptions may appear on the face or head, and sometimes on the entire body; ulceration may occur on the lips, gums, inside of the cheeks, and on the tongue; itching of the nose, twitching of the muscles, disturbed sleep, wakefulness, dilatation of the pupils, thirst, loss of appetite, all indicate an increase of the irritation; the temper becomes very irritable, and delay in the eruption of a tooth may cause congestion of the gum with swelling of the cheek; nausea and vomiting, diarrhea, fever, thirst, and other systemic disturbances, such as convulsions, etc., may soon succeed these symptoms. A premature eruption of the teeth is more liable to give rise to constitutional symptoms than a tardy or delayed eruption.

The salivary secretion, which is very scanty prior to the period of the eruption of the teeth, always increases as dentition approaches,

and in cases of difficult dentition becomes very profuse. A decided form of stomatitis may be present, and in some cases even abscesses have formed, which could only be relieved by incisions. As a general rule the degree of irritation present depends upon the number of teeth erupting, but, owing to the difference of susceptibility, one tooth may give rise to more irritation than the simultaneous eruption of several teeth will in other cases.

A perfectly healthy child, properly cared for, may erupt its teeth with little or no suffering, although there may be some restlessness, a slight decrease of appetite, and a slight elevation of the temperature of the mouth. At other times a mere local uneasiness may be experienced, which will induce the infant to place its finger in the mouth, or to bite upon some foreign substance, which apparently affords relief. In such cases as these the processes of the development of the teeth, and the absorption of the tissues confining them, are equal, and the result is that the teeth perforate the gum without causing either pain or irritation. Where, however, there is a difference in the progress between the growth of the teeth and the absorption of the opposing structures, then these different forces produce irritation, and a difficult dentition results.

When the eruptive period arrives, the roots of the teeth are yet incomplete, for instead of a conical end and the small opening or foramen which a completed tooth presents, there is a voluminous pulp occupying a cavity with an incomplete termination almost as large as the root itself; hence any considerable increase of vascular and nervous action produces a hyperæmia of the pulp which may cause its protrusion and induce thereby constitutional disturbance.

The immediate cause of the irritation is conceded to be due to the downward pressure of the root upon the nerves and vessels of the pulp of the tooth, such pressure being caused by the opposing gum, and giving rise to congestion and swelling, which have the effect of increasing the induration of the opposing tissues. Constitutional as well as local symptoms result from such irritation, some of which are of the most serious character. The cerebro-spinal system may become affected, giving rise to restlessness, sleeplessness, pain in the head, convulsions, or paralysis; also the respiratory system, a condition which is manifested by cough, catarrh, bronchitis, pneumonia, or spasmodic croup; also the alimentary canal, where there may be nausea, vomiting, loss of appetite, or diarrhea; also the skin may become affected, and such forms of skin disease may manifest themselves as eczema, acne, etc. Therefore, the period of dentition may be a dangerous one, for many infants die at this time, either from convulsions, from whooping cough, or cholera infantum. Difficult dentition is more

frequently a predisposing than a direct cause of infantile convulsions. At such a period a sensitive state of the nervous system, or an afflux of blood to the head, may result in convulsions, although such an affection may be the direct consequence of the irritation caused by the efforts of several teeth to erupt at the same time, especially in the case of weakly children.

The premonitory symptoms of convulsions are depression, restlessness, and fretfulness for some days before the paroxysm; the eyes have a wild, unnatural appearance, the sleep is disturbed, and sometimes there is unusual heat of the head, with a sudden starting or twitching of the limbs. In general convulsions, the paroxysm is characterized by a hot head during its early stage, and a flushed face, while in sympathetic convulsions the head is cool and the face pallid; the pulse is accelerated, as well as the respiration, which is also irregular, especially if the respiratory muscles are involved, which is usually the case. The muscles of the face, eyes and eyelids, and limbs are in a state of rapid involuntary contraction and relaxation; the features are distorted; the mouth is drawn out of shape, and the teeth become tightly closed, owing to the tonic contraction of the masseter muscles; and if the paroxysm is prolonged, frothy saliva may issue from the lips.

The eyelids are usually open, and in severe cases the pupils of the eyes are concealed under the upper lids, or the eyeballs may be forcibly drawn from side to side. The head is strongly retracted, or turned to one side; the thumbs and fingers are convulsively flexed, so that the former are turned across the palms and covered by the fingers; the great toe is adducted and the other toes are flexed, and with the legs move spasmodically; consciousness is lost. The duration of the paroxysm varies from a few minutes to several hours, generally averaging from five to fifteen minutes; and when it terminates favorably, the spasmodic movements gradually cease, and are followed by a deep inspiration and quiet or sleep, with a return of consciousness. The temperature and respiration become natural, although dullness and bewilderment of mind may continue for several hours. In severe cases, the respiration is so embarrassed and the circulation so retarded that congestion of various organs results. Death does not usually occur from one paroxysm, but from several at intervals, during the last of which convulsive movements cease, and there is no return of consciousness; the limbs grow cold, the pulse feeble, and coma supervenes.

The treatment of convulsions consists in first removing the irritation by the use of the gum-lancet, by emesis, purgatives, etc., according to the indications; the feet, as soon as possible, may be put in hot water,

to which mustard is added ; or a warm bath may be used ; such measures have a soothing effect upon the nervous system, and cause muscular relaxation and derivation of blood from the cerebro-spinal axis. They also prevent passive congestion and edema of the brain and lungs. Antispasmodics and nervous sedatives are indicated after the cause of the irritation has been removed. Cool applications, in the form of a cloth frequently wrung out in cold water, should be made to the head, to reduce its temperature, which will have the effect of contracting the vessels and membranes of the head, and diminishing the cerebral congestion. An aperient is useful, unless there has been previous diarrhea. An enema of soap and water will produce free and speedy evacuation, as it is often necessary to relieve the digestive canal of irritating substances.

For the relief of the paroxysm, and to lessen its duration, chloroform has been successfully employed as an anesthetic, but as it is a dangerous agent, the bromid of potassium is preferable, in doses of three grains for a child one year of age, or four or five grains for a child of two or three years of age, dissolved in cold water, and administered every ten minutes ; after the convulsions cease, there should be longer intervals between the doses. In very severe cases, where the bromid of potassium may not act with the required promptness, the hydrate of chloral may be employed in doses of five grains for a child of one year of age, and ten grains for one of four years of age, dissolved in two or three drachms of water, and injected, by means of a small syringe, into the rectum. The bromid of potassium may be combined with the chloral as follows: *R.* Potassii bromid. gr. xvj ; Chloral. hydrat. gr. iv to vj ; Sodii bicarb. gr. xv ; Aquæ menth. pip. f3j. *M.*

This remedy is generally successful in controlling the spasmodic movements in five or ten minutes, unless recovery is impossible. During such premonitory symptoms of difficult dentition as fretfulness and nervous excitement, the bromid of potassium is a useful and safe remedy. Demulcent and soothing lotions are useful to reduce the swelling and tenderness of the gums ; and an ivory or rubber ring, for the child to bite upon, will afford great relief.

The practice of rubbing the gums with a thimble or ring is injurious, as the swelling and tenderness are increased.

Unless the tooth is on the point of protruding, the operation of lancing the gum is by many thought to be unnecessary, for the reason that the gum is not rendered tense by the pressure of the advancing tooth, and too much importance has been attached to the supposed tension and resistance of the gum.

When the symptoms are local and the gums are somewhat congested

and swollen, scarifying them lightly with a very sharp lancet will often afford relief; but if the gums are very tender this operation should not be performed.

Others, again, advocate the operation of lancing the gums in difficult dentition, even when no single local indication exists in the mouth, by making free incisions over the teeth whose eruption is anticipated, the cuts extending through the gum to the presenting surface of the tooth, and thus affording manifest and complete relief. No injury results to the erupting tooth, or to the germ of the developing permanent one, if the lancet is carried to the surface of the crown, without undue force is employed. Partially erupted canines and molars sometimes require the use of the lancet to relieve the pressure of the enclosing band of gum tissue. Such objections against lancing the gums, as the infliction of great pain and uncontrollable hemorrhage, are of little moment, as is also the assumed increased

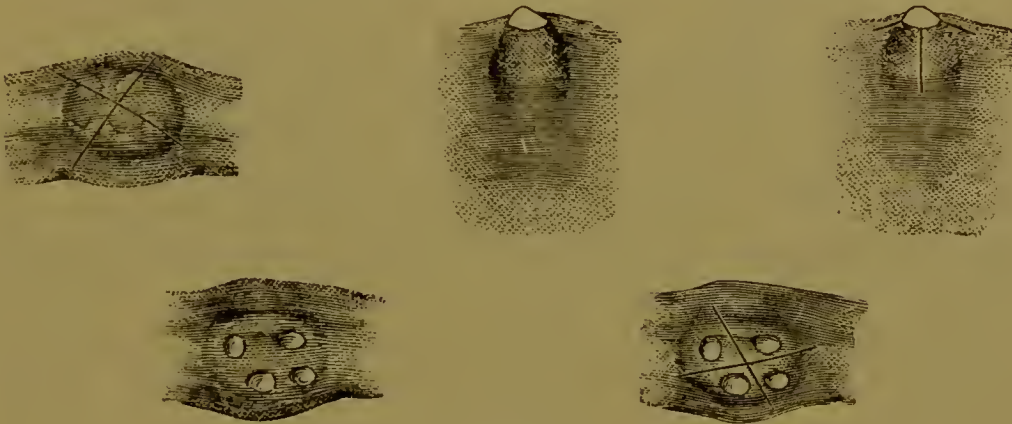


FIG. 114.

resistance of cicatricial tissue; for, although the wound made by the lancet should heal before the appearance of the tooth, this cicatricial tissue is easier absorbed, and consequently less resistant.

For lancing the gum over an incisor, a single incision in the line of the arch will answer; the molars generally require a crucial incision, and the gum of the canines, even after the point of the cusp has emerged, may require severance on the lateral, anterior, and posterior surfaces, in order to relieve the tension and liberate these teeth. The illustrations (Fig. 114) show the necessary incisions for the different classes of teeth. Should undue bleeding result from such an operation, it can be arrested by means of a little finely powdered alum applied to the incisions; should such a remedy fail, more powerful astringents or styptics can be employed, such as tannic acid, styptic colloid, matico, powdered resin, etc. Nitrate of silver and the iron preparations are liable to cause slough and secondary hemorrhage; hence should never be employed in such cases. As the act of

sucking the gums may promote persistent bleeding, in such cases the child should be either placed at the breast of the nurse, or a gag of soft linen be introduced in such a manner as will prevent the infant from sucking its gums. Internal remedies in case of a hemorrhagic diathesis are indicated to correct an abnormal or depraved condition of the blood and promote contraction of the orifices of the bleeding vessels; but their use is seldom necessary.

When such remedies are indicated, tincture of the muriate of iron, acetate of lead, aromatic sulphuric acid, gallic acid, and turpentine are the agents to be employed. Dr. James W. White gives the following formula which will meet all the indications in such cases:—

℞.	Tinct. ferri chloridi,	f℥ ss.	
	Acid. acetic. dil.,	f℥ j.	
	Liq. ammonii acet.,	f℥ j.	
	Ext. ergot. fld.,	f℥ ij.	
	Syr. simp.,	f℥ ss.	
	Aquæ,	q. s. ad f℥ iij.	M.

Dose, a teaspoonful every three hours for a child six months old.

It is not unusual for some children to be affected with diarrhea during the period of dentition, and which may be accompanied with irritability of the stomach. Where not too debilitating and protracted, the diarrhea is beneficial, but, on the other hand, it must not be neglected and permitted to become a source of danger. But there are often other causes for this affection than those which can be attributed to dentition, such as improper food and clothing, residence in unhealthy localities, and exposure to cold.

The diarrhea, when severe, should be controlled by proper remedies, capable of reducing the number of evacuations to two or three daily, as a greater number may result in danger to the child. The treatment of the diarrhea of dentition consists in a change in the diet, the adoption of hygienic measures, and, when medicines are necessary, the administration of the milder purgatives in small doses. Where the dejections are acid, as is shown by the green color, half a teaspoonful to one teaspoonful of castor oil or calcined magnesia will prove beneficial. According to Dr. West, if there be neither much pain nor tenesmus, and the evacuations, though watery, are fecal, and contain little mucus and no blood, very small doses of the sulphate of magnesia and tincture of rhubarb are more useful than any other remedy.

℞.	Magnesia sulphatis,	℥ j.	
	Tinct. rhei,	℥ j.	
	Syr. zingiberis,	℥ j.	
	Aquæ carui,	℥ ix.	M.

SIG.—One dram three times a day, for children one year old.

Dr. Christopher Elliott recommends half to one dram doses of the infusion of chamomile-flowers for infantile diarrhea of dentition, when the evacuations are greenish in color or are slimy and streaked with blood.

For the diarrhea of infants due to indigestion, and attended with acidity, Professor J. L. Smith recommends the following:—

℞. Pulv. ipecac., gr. ss.
 Pulv. rhei, gr. ij.
 Sodæ bicarb., gr. xij. M.
 Divide into chart No. xij. One powder every four to six hours, for
 an infant one year old.

The same author also recommends the following in the non-inflammatory diarrhea of infants:—

℞. Tinct. opii deodorat., gtt. xvj.
 Bismuth. subnitrat., ℥ ij.
 Syr. simplic., ℥ ss.
 Mistur. cretæ., ℥ iss. M.
 Shake well, and give one teaspoonful from three to four hours.

For increased excitability of the intestine due to dental irritation, which is indicated by frequent stools of semi-solid matter containing undigested food, Dr. Lees recommends the use of bromid of potassium in from three to five-grain doses every three or four hours for a child one year of age. Persistent constipation may be treated with ten-drop doses, three times daily, of cod-liver oil, increasing the dose if necessary to a half dram.

For the skin affection attending dentition, such as eczema in the acute form, with a watery discharge and an irritable skin, oxid of zinc, used as a dusting powder, will prove serviceable, but the parts should not be washed with water.

When the discharge is thicker and more purulent, and forms scabs, they may be removed by bathing the part with oil and washing it with soap and water, and a salve applied, composed of equal parts of vaseline and simple lead plaster; or less of the lead plaster may be used with the vaseline, if the salve should prove too strong; or an ointment may be employed, composed of oxid of zinc, five grains, and simple salve, one ounce.

When the gum over an erupting tooth appears swollen and congested, and at length ulcerates, even after the tooth is protruding, a condition to which the appellation “odontitis infantum” has been applied, the ulcers may be touched with a crystal of alum, and a lotion composed of sage tea and honey used, with decided advantage. For a sloughing condition of the mucous membrane over an

erupting tooth, the careful application of strong carbolic acid will prove efficient.

During infancy, and especially during the period of dentition, the clothing should consist of fine, soft flannel next to the skin, to protect the body from variations of temperature, and all changes be made gradually. The food for some months after birth should be confined exclusively to milk, that of the mother being preferable when she is in good health. For artificial food, when such is necessary, an excellent preparation is that of Dr. J. F. Meigs, which consists of equal parts of milk, cream, lime-water, and oatmeal, barley- or arrowroot-water, to which a little sugar of milk is added.

SECOND DENTITION.

The design of nature is to preserve the deciduous teeth until their roots are absorbed and they become loose, and are removed to make room for their permanent successors. But the eruption of the permanent teeth begins before any of the deciduous teeth are removed. Between the ages of five and a half and six years, the first permanent molars make their appearance; hence they are commonly called "sixth-year molars," and their germs, with those of the remaining permanent teeth, are progressing with the development of the deciduous teeth.

When the permanent teeth are developing, and their crowns, on account of the growth of the roots, are approaching the alveoli of the deciduous teeth, a process of absorption, decalcification, commences, by which the roots of the latter teeth are gradually destroyed, the dissolving process going on until only the crowns of the deciduous ones remain. The process of absorption affects the roots of the deciduous teeth in the order corresponding to their development and eruption; the inferior central incisors are first shed, then the superior central incisors, then the lateral incisors; and this order is preserved until all of the deciduous teeth have been removed or have become so loose that they are easily extracted.

The absorptive process commences in the alveoli of the deciduous teeth, and then attacks the apices of their roots, and in some cases progresses until it involves a large portion of the crowns. The loss of substance commences generally upon the side of the root, near the apex, toward the advancing crown of the permanent tooth, and the surface of the root acted upon presents pits, grooves, or irregular facets, with rough surfaces and sharp edges, such as would result from corrosion. If a deciduous tooth undergoing this process of absorption be extracted, a loose, spongy substance is found adherent to it, which Laforgue and Bourdet supposed to be an

absorbent organ—vascular papilla—secreting a fluid capable of dissolving the tooth-structure. According to Wedl, a fluid is secreted by the cells of this organ which dissolves the hard substance, and referring to the theory held by some, he says “that these cells are of a parasitic nature, that is to say, that the dental substances are eaten up, as it were, since the cells absorb the latter, and he remarks that “possibly aneboid movements may be the occasion of the wasting of the tissues;” he is also of the opinion that the organ of absorption is developed from the connective tissue of the root membrane of the deciduous tooth. According to a microscopic examination made by Mr. Tomes, the surface of this absorptive organ is made up of peculiar multiform cells, each one being composed of several smaller

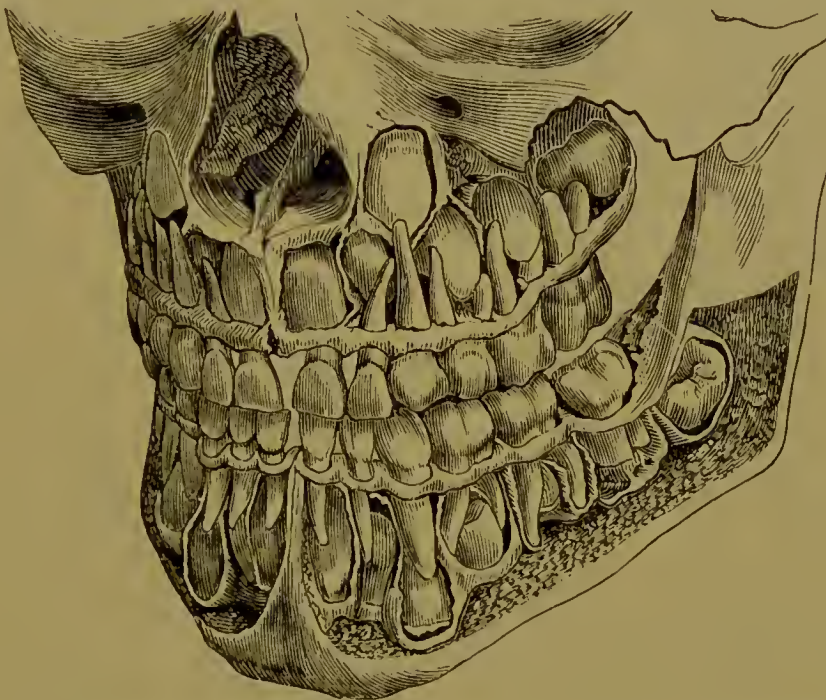


FIG. 115.—ILLUSTRATES THE JAWS OF A CHILD BETWEEN SIX AND SEVEN YEARS OF AGE SHOWING THE RELATIONS OF THE TWO SETS OF TEETH.

cells, the number varying from two to three to as many as fourteen or fifteen.

Some have regarded the method employed by nature for the removal of the roots of the temporary teeth as *sui generis*, but there is a better reason for considering it to be the effect of an inflammatory process that brings about a proliferation of cell-growth, which may at one time act as an absorbent and at another be reparative. As to the precise manner in which these cells of the absorbent organ act, much remains to be learned, but that it is a physiological process, and occasioned by the action of cells known as “osteoclasts,” or “odontoclasts,” and is not a mechanical force, is now quite generally admitted. These cells secrete what has been termed “a soluble

ferment," or "fluid of exudation," which dissolves out the lime salts from the hard tissues with which it comes in contact, the surface acted upon presenting a series of pits and cup-shaped depressions.

Dr. C. N. Pierce, in an excellent article, entitled "Calcification and Decalcification of the Teeth,"* and which is illustrated by the following instructive figures (Fig. 116), in treating of the absorption or decalcification of the roots of the deciduous teeth, regards this process "as being both physiological and somewhat obscure," and he further states:—

"The evidence that it is the result of a physiological action is the fact that it matters not to what extent absorption has progressed, the very moment vitality of the pulp ceases that instant this retrograde metamorphosis terminates. What induces this molecular dissolution it is difficult to state, though the several conditions which are always present are readily recognized; but the part they play is so obscure that it is not readily ascertained. The manner of its commencement when successful—always at the end of the root—and the presence of a vascular papilla in close proximity to the absorbing surface, are, with the retention of pulp vitality, three essential accompaniments, and the absence of any one of them would militate against the completion of the process.

"The statement that the presence and pressure of the permanent tooth are essential, cannot be sustained, for frequently the decalcification of the deciduous tooth is successfully accomplished in the absence of its successor; and again, how often do we find the permanent tooth impacted against or within the bifurcated roots of the deciduous molar, or pressing down by the side of its single-rooted predecessor, both being more or less displaced by the persistence of the deciduous tooth without absorption. That the organ has served its purpose, and that the nourishment which had previously been appropriated by it is diverted or relegated to its successors, is probably the most plausible explanation we can give of this interesting physiological process."

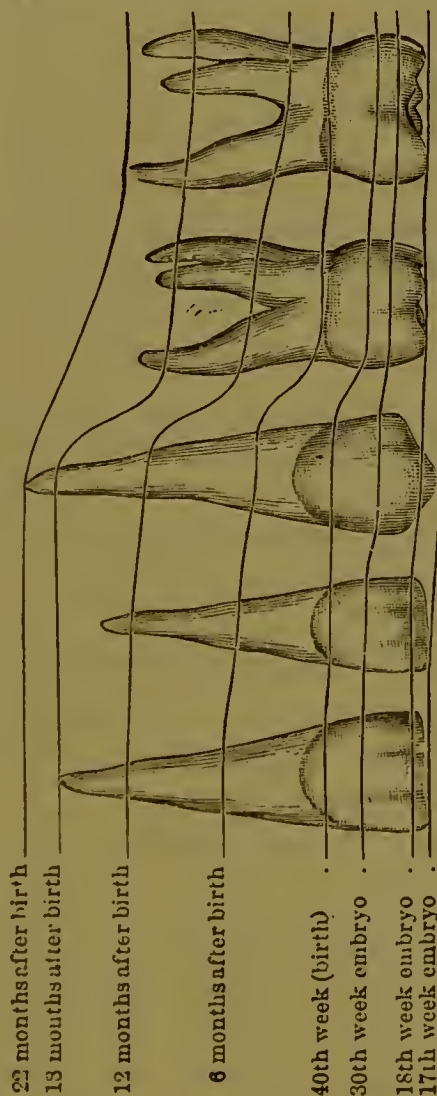
The average time and order for the eruption of the permanent teeth are as follows:—

First molars,	5 to 6 years.
Central incisors,	6 " 8 "
Lateral incisors,	7 " 9 "
First bicuspid,	9 " 10 "
Second bicuspid,	10 " 12 "
Canines,	11 " 13 "
Second molars,	12 " 14 "
Third molars, or wisdom teeth,	17 " 21 "

* *Dental Cosmos*, August, 1884.

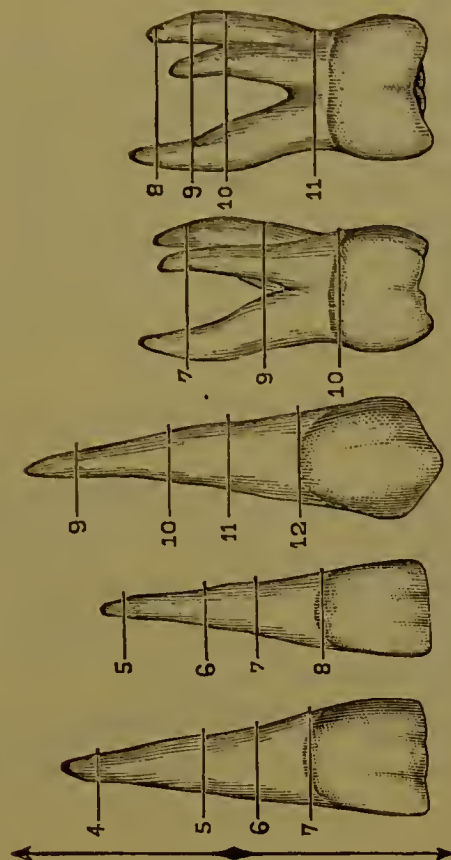
CALCIFICATION AND DECALCIFICATION OF THE TEETH.

FIG. 1.



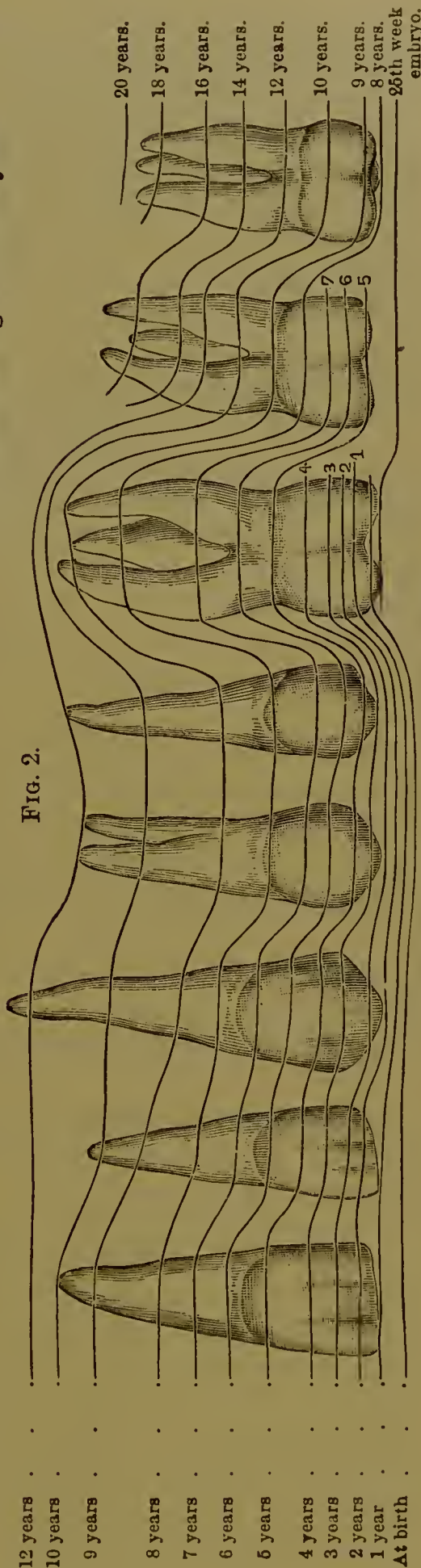
Calcification of the Deciduous Teeth.

FIG. 3.



Decalcification of the Deciduous Teeth.
The numbers on Fig. 3 indicate years.

FIG. 2.



Calcification of the Permanent Teeth.

From a Paper by DR. C. N. PEIRCE, in the DENTAL COSMOS for August, 1884.

Usually little or no difficulty attends the eruption of the permanent teeth, with the exception of the third molars of the lower jaw, which may cause considerable trouble and suffering, on account of their being crowded between the second molar and the ramus or ascending portion of the jaw, the space left being insufficient to accommodate the third molar. Inflammation from such a cause may extend to the soft tissues, such as the muscles, and render the act of swallowing difficult and painful, and that of mastication impossible. The inflammation thus caused may also terminate in suppuration, and the pus discharge at remote points, internal or external. Such maladies as neuralgia, hysteria, epilepsy, St. Vitus' dance, disordered vision, earache, deafness, tetanus, etc., have been caused by the eruption of the third molar. Occasionally the eruption of the molars anterior to the third molars may be attended with some constitutional disturbance, such as headache, slight neuralgic pains, impaired appetite; and also local symptoms, such as swollen gums, increased heat of mouth, and an increased flow of saliva. The extraction of the third molar may be necessary in some cases; in others, that of the second molar, although the removal of a carious first molar may sometimes relieve the crowded condition of the arch, when the trouble is owing to a want of space between the second molar and the ramus of the jaw. The lancing of the gum over a third molar not yet protruded often relieves. The most common period of suffering from second dentition, apart from that of the third molar, is from the tenth to the thirteenth year, and it is characterized by such affections as obstinate and protracted cough, with paroxysms of long duration, also diarrhea, wasting of flesh, nervous diseases, loss of spirits, headache, and morbidly sensitive and painful eyes.

The obstinate cough disappeared when the molar teeth pierced the gums; and a mixture of iron and nitric acid was successful in immediately curing a patient of seven years of age in the practice of Dr. James Jackson, who recommends the following remedies as being most useful:—

“First, a relief from study or from regular tasks, yet using books so far as they afford agreeable occupation or amusement. Second, exercise in the open air, preferring the mode most agreeable to the patient, and in more grave cases the removal from town to country.”

Fig. 117 represents an instrument, the invention of Mr. Woodhouse, and introduced by Dr. L. D. Shepard, designed for the removal of the overlying gum which covers the masticating surfaces of the first and third molars very often for months after the cusps have appeared through the gum, and thus promotes, if it does not cause, the decay so frequently attacking these teeth upon their eruption. An incision

is made with a lancet, through the gum, along the anterior margin of the tooth, and the thin, flat blade of the cutter is inserted; then, by closing the handles, the section of gum the size of the blade is instantly removed. The operator will find this process much more effectual; and far easier to the patient, than the usual practice of cutting the gum in different directions.

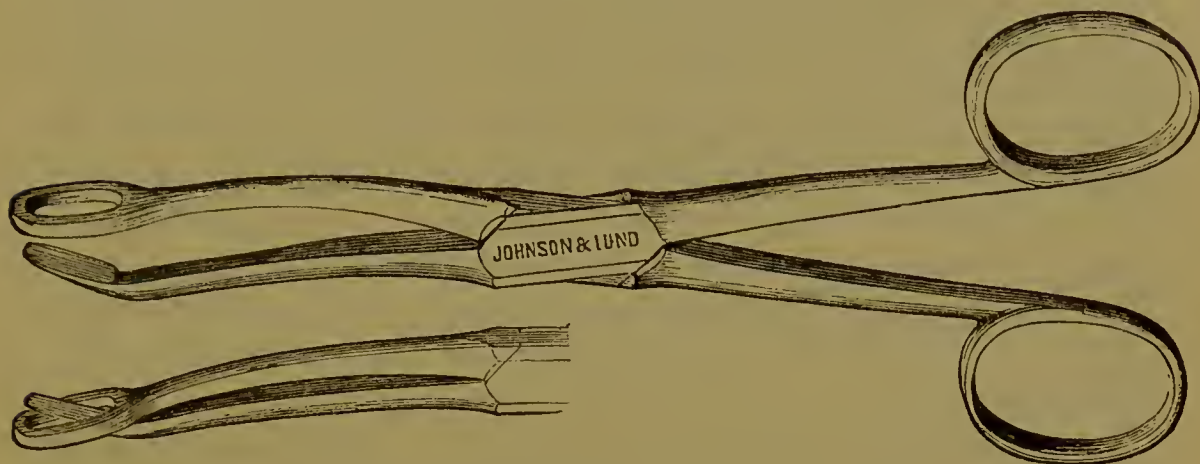


FIG. 117.

THIRD DENTITION.

That nature sometimes makes an effort to produce a third set of teeth is a fact which, however much it may be disputed, is now so well established that no room is left for cavil or doubt.

The following interesting particulars are taken from "Good's Study of Medicine:"—

"We sometimes, though rarely, meet with playful attempts on the part of nature to reproduce teeth at a very late period of life, and after the permanent teeth have been lost by accident or by natural decay.

"This most commonly takes place between the sixty-third and eighty-first year, or the interval which fills up the two grand climacteric years of the Greek physiologist, at which period the constitution appears occasionally to make an effort to repair other defects than lost teeth. . . .

"For the most part, the teeth, in this case, shoot forth irregularly, few in number, and without proper roots, and, even where roots are produced, without a renewal of sockets. Hence, they are often loose, and frequently more injurious than useful, by interfering with the uniform line of indurated and callous gums, which, for many years, perhaps, had been employed as a substitute for the teeth. A case of this kind is related by Dr. Bisset, of Knayton, in which the patient, a female in her ninety-eighth year, cut twelve molar teeth, mostly

in the lower jaw, four of which were thrown out soon afterward, while the rest, at the time of examination, were found more or less loose.

“The German Ephemerides contain numerous examples of the same kind; in some of which teeth were produced at the advanced age of ninety, a hundred, and even a hundred and twenty years. One of the most singular instances on record is that given by Dr. Slade, which occurred to his father, who, at the age of seventy-five, reproduced an incisor, lost twenty-five years before, so that, at eighty, he had hereby a perfect row of teeth in both jaws. At eighty-two they all dropped out successively; two years afterward they were all successively renewed, so that at eighty-five he had once more an entire set. His hair, at the same time, changed from a white to a dark hue; and his constitution seemed, in some degree, more healthy and vigorous. He died suddenly, at the age of ninety or a hundred.

“Sometimes these teeth are produced with wonderful rapidity; but in such cases with very great pain, from the callosity of the gums through which they have to force themselves. The Edinburgh Medical Commentaries supply us with an instance of this kind. The individual was in his sixty-first year, and altogether toothless. At this time his gums and jawbones became painful, and the pain was at length excruciating. But within the space of twenty-one days from its commencement, both jaws were furnished with a new set of teeth, complete in number.”

A late physician of Baltimore informed the author, in 1838, that an example of third dentition had come under his own observation. The subject, a female, at the age of sixty, he assured him, erupted an entire new set in each jaw.

The following extract of a letter from a professional friend* describes another very interesting case:—

“I have just seen a case of third dentition. The subject of this ‘playful freak of nature,’ as Dr. Good styles it, is a gentleman residing in the neighborhood of Coleman’s Mill, Caroline County, Virginia. He is now in his seventy-eighth year, and, as he playfully remarked, ‘is just cutting his teeth.’ There are eleven out, five in the upper and six in the lower jaw. Those in the upper jaw are two central incisors, one lateral and two bicuspid, on the right side. Those in the lower are the four incisors, one cuspid and one molar. Their appearance is that of bone, extremely rough, without any coating or enamel, and of a dingy brown color.”

* Dr. J. D. McCabe.

Two cases somewhat like the foregoing have come under the author's observation. The subject of the first was a shoemaker, Mr. M., of Baltimore, who erupted a lateral incisor and cuspid at the age of thirty. Two years before this time he had been badly salivated, and, in consequence, lost four upper incisors and one cuspid. The alveoli of these teeth exfoliated, and at the time he first saw him were entirely detached from the jaw, and barely retained in the mouth by their adhesion to the gums. On removing them, he found two white bony protuberances, which, on examination, proved to be the crowns of an incisor and cuspid. They were perfectly formed, and though much shorter than the other teeth, yet up to 1845 they remained quite firm in the jaw.

The subject of the other case was a lady residing near Fredericksburg, Virginia, who erupted four right central incisors of the upper jaw successively. One of her temporary teeth, in the first instance, had been permitted to remain too long in the mouth, and a permanent central incisor, in consequence, came out in front of the dental arch. To remedy this deformity, the deciduous incisor was, after some delay, removed; and about two years after, the permanent tooth, not having fallen back into its proper place, was also extracted. Another two years having elapsed, another tooth came out in the same place and in the same manner, and, for similar reasons, was also removed. To the astonishment of the lady and her friends, a fourth incisor made its appearance in the same place, two years and a half after the extraction of the first permanent tooth. When it had been out about eighteen months, the author was called in by the lady, who wished him, if possible, to adjust it. Finding that it could not be brought within the dental circle, he advised her to have it extracted and an artificial tooth placed in the proper place in the arch.

In the second number of the eighth volume of the *American Journal of Dental Science*, the history of a case of four successive dentitions of the upper central incisors is given.*

The following interesting case is related by Dr. B. H. Catching in the *Southern Dental Journal* for October, 1886. The patient was a girl, born August 6, 1871, very small and delicate, having been a six-months' child.

At the age of six months the eruption of the teeth began, and at seven months she possessed a full set of diminutive teeth, all of which were shed within three months. When eleven months old, teeth again began to erupt, and at the age of fifteen months a second full set was in her mouth. These soon crumbled away, and her mouth was with-

* Dr. W. H. Dwinelle.

out teeth until she had arrived at the age of two and a half years, when a third set began to erupt. The child weighed at this time but ten pounds, and this third set of teeth caused her so much trouble that the mother endeavored to have them extracted, and not being able to induce a dentist to perform the operation, she extracted twelve of the teeth herself in order to give relief to her child; and all of the third set were removed prior to her fourth year of age. She remained without teeth until her eleventh year, when her last and permanent set began to erupt, nearly all of which were, at the date of writing this account, in her mouth, sound and firm. Her last set is deficient in one superior central incisor, one superior left bicuspid, two inferior right bicuspid, and an inferior left cuspid and bicuspid. At seven years of age this child weighed but thirty pounds, but at fifteen years of age she had developed into a stout, strong girl. Dr. T. T. Moore, of S. C., verifies this case, as the child was under his care also, both himself and Dr. Catching having carefully observed the conditions and development from the beginning to the end.

Concerning the manner of the origin and formation of teeth of third dentition, adopting Wedl's views, germs may lie dormant for many years in the animal organism, until they are subjected to favorable conditions which enable them to develop. The crowns of such teeth only being formed, while the roots are stunted, is clearly due to the small depth of the jaws in old age.

CHAPTER III.

DISEASES OF THE ORAL MUCOUS MEMBRANE.

STOMATITIS.

THE diseases of the mucous membrane lining the mouth, very common at the periods for the eruption of the teeth and later in life, are comparatively rare during fetal life, and differ, as regards symptoms, in accordance with the nature of the affection and the part of the mucous surface in which it may have its origin.

The most common affection of the membrane lining the mouth is known by the general term *stomatitis*, from the Greek word *στομα*, "mouth," and *itis*, a "suffix denoting inflammation," and is described by Prof. Wood as follows:—

"Inflammation of the mouth appears in reddened, somewhat elevated patches, or occupies large portions of the surface, sometimes extending

apparently over the whole mouth. In some cases it is superficial, with little or no swelling, and may be designated as *erythematous*, from the Greek word *ερυθροζ*, 'red;' in others it occupies the whole thickness of the membrane, extending sometimes to the submucous tissue, and even to the neighboring structures, as the sublingual and submaxillary glands, and the absorbent glands of the neck, and occasions considerable tumefaction in all these parts. In the erythematous form it is characterized by redness and sense of heat, and sometimes considerable tenderness, but is not usually attended with acute pain; when deeper in the tissue it is often very painful.

"Portions of the epithelium sometimes become opaque, giving an appearance of whiteness in streaks or patches. Occasionally this coating is elevated in blisters, or even detached, like the cuticle from the skin in scales. Superficial ulcerations not unfrequently occur, which may spread over considerable portions of the membrane. In certain states of the constitution the ulcerative tendency is very strong and deep, and extensive sores occur, which are sometimes attended with gangrene.

"There is often a copious flow of saliva; though, in some instances, this secretion, as well as that of the mucous follicles, is checked, and the mouth is clammy or dry. The sense of taste is usually more or less impaired, and speech and mastication are often difficult and painful. When the tongue is affected, its surface is, in general, first covered with a whitish fur, through which the red and swollen follicles may often be seen projecting. This fur sometimes breaks off, leaving the surface red, smooth, and glossy, with here and there prominent follicles; or the surface may be hard, dry, or gashed with painful fissures. When the gums are involved, they swell, and rise up between the teeth, around the necks of which they frequently ulcerate. In some cases this ulceration does not cease until it has extended into the sockets, and destroyed altogether the connections of the teeth, which become loosened and fall out, after which the gums will heal.

"Ordinary inflammation of the mouth is seldom so violent as to induce symptomatic fever. This form of inflammation is more frequently a complication of other diseases than an original affection. When of the latter character, it is generally caused by the direct action of irritant bodies, as by scalding drinks, acrid or corrosive substances taken into the mouth, or unhealthy secretions from decayed teeth. The sharp edge of a broken tooth sometimes gives rise to much inflammation, and even deep and obstinate ulcers, especially of the tongue. Inflammation of the mouth may also result from the reaction which follows the long contact of very cold substances, such as ice, with the interior of the mouth. It sometimes proceeds from the propa-

gation of inflammation from the fauces, and is a frequent consequence of gastric irritation produced by sour or acrid matter in the stomach. Drunkards seem peculiarly predisposed to it. Of the constitutional causes none are so frequent as the state of fever, which, whatever may be its peculiar character, is very apt to affect the mouth, and not infrequently occasions inflammation."

Catarrhal Stomatitis.—Catarrhal stomatitis may be either acute or chronic, and a simple form is common to children under the age of one year; while this simple form gives rise in itself to no severe symptoms, yet it may be connected with other serious maladies, and hence is often overlooked. Acute catarrhal stomatitis first appears in the form of bright-red patches at the angles of the mouth and on the inside of the cheeks, which increase in size and sometimes unite, when the entire mucous surface of the mouth may become inflamed. While it is more intense in one part than in another, it may be confined to the tongue alone, or be universally diffused over the whole mucous membrane of the mouth. It is characterized by an increase of the heat and redness of the part affected, rapid proliferation and exfoliation of epithelial cells, and more or less dryness of the surface, as there is but little mucus secreted, with a high degree of sensibility, and pain when the lips or tongue are moved. The pain is of a smarting, burning character, the result of irritation on a denuded surface. Owing to the limited extent of connective tissue, the swelling of the inflamed mucous membrane is generally slight. In severe cases the gums become swollen and spongy, and bleed readily, and the entire surface of the mouth and tongue is covered with a white, viscid mucus; there is an increased flow of saliva, that is acrid and irritating, which may dribble from the corners of the mouth, causing a greater degree of congestion, which is apparent by the dark red color of the affected membrane. A fetid condition of the breath is not common to the acute form of catarrhal stomatitis unless shallow ulcers are present, which result from the rapid loss of the superficial cells and a failure in the development of others to supply their places. The engorgement of the vessels of the mucous membrane is followed by the exudation of white blood-corpuscles.

The intensity of this affection varies in different cases, sometimes existing in such a slight form as to cause little uneasiness, and quietly disappearing, while at other times it may cause intense pain, and continue for weeks or months.

In a severe form it may extend to the esophagus and stomach, or the larynx and trachea, and at last prove fatal, especially if there is present a decided state of cachexia, or a severe co-existing disease.

When it occurs during the period of dentition, to which it is com-

mon, it is often accompanied with fever, and sometimes, especially when long continued, by a profuse flow of saliva; occurring previous to dentition, it is seldom accompanied with fever.

When caused by some disease coincident with the period of dentition, the gum over the erupting tooth becomes inflamed, and the inflammation may extend over the entire buccal surface. But when due to the irritation of dentition, this form of stomatitis is generally more circumscribed than when it arises from a constitutional cause. It may also result from a mercurial course of treatment, exposure to cold, hot and stimulating food, or a diseased condition of the alimentary canal.

In adults catarrhal stomatitis may result from long-continued irritation of the mucous membrane of the mouth, or from injuries to the gums, such as may result from laceration in the extraction of teeth; also from the sharp edges of fractured teeth and roots, and constitutional derangement.

In very young children, among the early symptoms are restlessness and fretfulness, with refusal to take food, or, when attempting to do so, suddenly ceasing on account of the pain experienced.

Chronic catarrhal stomatitis is characterized by the structural changes which ensue on account of the stroma becoming affected. The mucous surface affected becomes indurated and thickened, the mucous glands are obstructed, and, as a result of their secretion being arrested, they become encysted and present a granular appearance on the surface of the membrane. The breath is more or less fetid, owing to the secretions of the mouth becoming vitiated, and the teeth are coated with sordes. The papillæ of the tongue become hypertrophied, but the substance beneath is less affected than in the acute form of this affection. The duration of the acute form is from three to six days, as a general rule, while the chronic form is more persistent.

Simple stomatitis of children is readily relieved by means of emollient washes, such as solutions made from the slippery elm bark or the pith of sassafras, in cold water. When severe, a leech or two applied to the angle of the jaws will prove serviceable, and as a wash, the acetate of lead, in a solution composed of three grains to one fluidounce of water. A few doses of bromid of potassium may relieve the nervous excitement and fretfulness. One part of borax to three of honey, or a dram of borax to an ounce of glycerin and water, or a weak solution of alum, may prove useful local remedies.

The treatment of catarrhal stomatitis consists in first removing the cause of irritation, when such is present, and the use of alkaline washes, or, in more obstinate cases, a solution of either chlorid of

zinc or nitrate of silver, one grain to the ounce of water. Phenol sodique or phenate of soda will correct the fetor of the breath, when used in the form of spray. For the chronic form the following may be applied to the inflamed mucous surface, either in the form of a gargle or spray:—

R.	Acidi carbolici,	℥j.	
	Olei gaultheriæ,	℥ij.	
	Glycerini,	℥ij.	
	Olei menthæ piperitæ,	℥iij.	M.

When the inflammation of the mouth is symptomatic of a diseased condition of the alimentary canal, the remedies adapted to such a condition are necessary.

Ulcerous Stomatitis, also known as “Noma,” is another affection of the mouth which is common to childhood, the premonitory symptoms being the same as in simple stomatitis. The inflammation usually begins upon the gums and extends along the buccal surface. An examination of the mouth, however, at this stage of the disease, reveals one or more small, inflamed, and slightly elevated points or pimples, which, sometimes within a few hours, but more commonly after one or two days, present a softened and yellowish apex, and at length a small ulcer, superficial at first, but gradually becoming deeply excavated, with often an inflamed and elevated margin. The surfaces of these ulcers are covered with an ash-colored or a yellowish matter, in the majority of cases; but sometimes, instead of being thus covered, their surfaces are bare, and bleed readily.

Some of the ulcers may unite and form large, irregular ulcerations, while others remain isolated. The ulceration, when severe, gives rise to considerable swelling, especially around the ulcers, and the swollen part is soft, and not very tender on pressure. The soft, yielding nature of the swelling enables this form to be distinguished from gangrenous ulceration, as there is more induration in the latter affection. These ulcers result from acute phlegmonous inflammation, and may attack any part of the mucous membrane lining the mouth, but are most commonly found on the sides of the frenum, along the inferior margin and edges of the tongue, and inside the lips.

It is but seldom that they are found on the upper surface of the tongue; but when they do appear on this surface, they are generally superficial, and not deeply excavated.

When the ulcers in this form of stomatitis are fully formed, there is usually a profuse flow of saliva and a decrease of the febrile excitement. The bowels, which in the first stage of the disease are costive, now become loose, and often very much so during its con-

tinuance. A simple form of ulcerous stomatitis is characterized by but one or two small ulcers, which in a little time fill up with granulations and soon heal over. In a more severe form of this disease a considerable number of these ulcers exist, in some cases covering almost the whole of the mucous membrane of the gums, the inside of the cheeks, arch of the palate, sides and inferior surface of the tongue.

During the early stage of ulcerous stomatitis the mouth becomes hot and painful and the submaxillary glands swollen and tender. The breath becomes very offensive as soon as the ulceration is well established, and there is a tendency to keep the mouth open.

Another form of this disease is sometimes met with where but one or two ulcers exist, but which gradually extend over the mucous surface, at the same time increasing in depth, and with no appearance of healing. This form of the affection is attended with hectic fever, the exacerbations occurring night and morning, and rapidly wearing away the strength.

There is yet another form of ulcerous stomatitis occasionally met with, which consists of a softening of the mucous membrane of the palate in its centre, either on the median line or outside this line. The membrane appears to be softened into a kind of pulp, of a red or fawn color, which, on its removal, discloses an ulcer with perpendicular walls; the bone, however, forming its base is found to be perfectly healthy. It is the opinion of some that ulcerous stomatitis is contagious; that is, that it may be communicated by using the same spoon in eating, and also that it is endemic and epidemic. Ulcerous stomatitis is common to the period of dentition, especially when there is disorder of the digestive organs.

The causes of ulcerous stomatitis are uncleanliness, poor food, residence in damp, dirty places, mercury, a cachectic condition, enfeebled system, and contagion.

The treatment of ulcerous stomatitis consists in a change of residence and diet, cleanliness, the use of tonics, ferruginous or vegetable, such as the liquor ferri nitratis, with tincture of calumba, given in simple syrup, tincture of chlorid of iron, and sulphate of quinin, or cod-liver oil, and such local remedies as dilute chlorid of zinc, carbolic acid, nitrate of silver, muriatic acid, with an alternate wash of honey and borax, equal parts; or the chlorid of lime applied dry to the ulcerated surface twice daily, and simple water used during the interval, and continued until a healthy appearance is apparent, when a weak solution of chlorid of lime, one grain to forty-five of water, is employed. Chlorid of lime one dram, with honey one ounce, is also recommended. Chlorate of potassium often

acts like a specific, employed internally and externally, the dose of which is two or three grains, dissolved in water with sugar, or in syrup.

The following formula may be employed :—

R.	Potass. chlorate,	℥ ss to j.	
	Mellis,	℥ ss.	
	Aquæ,	℥ ij.	M.

One teaspoonful every two hours, and also applied as a lotion.

Dr. Condie recommends the following treatment where the ulcers are slow in healing : A solution of borax, gr. xv to the ounce of water, or a weak solution of the nitrate of silver, gr. j to the ounce of water, or sulphate of copper, gr. v to the ounce of water, or acidum nitricum dilutum applied by means of a camel's hair pencil to the whole of the ulcerated surface, which will improve the character of the ulceration and arrest its progress.

“Any apparent cause of irritation, such as a decayed tooth, should be removed.” When there is great derangement of the alimentary canal accompanying ulcerous stomatitis, or this disease occurs during the course of other acute and chronic diseases, such as pneumonia, scarlet fever, smallpox, etc., the proper remedies adapted to the removal of these diseases are necessary.

Aphthous Stomatitis.—This form of stomatitis, sometimes called “follicular stomatitis,” and also “canker sore-mouth,” although it is not confined to the seat of the follicles, is common to all ages, but is most frequent during childhood. The seat of the aphthæ is usually the inner surfaces of the lips and cheeks, the gums, the tongue, and sometimes the roof of the mouth. They commence with a vascular injection, which is followed in a few hours by a whitish exudation immediately below the epithelium and upon the corium, in the form of small, round or oval, isolated spots, the smallest being of the size of a pin's head, but the greater number of a diameter of one or two lines, causing slight vesicle-shaped elevations on the surface of the mucous membrane. The vesicles have a whitish appearance with an inflamed ring about their base ; after their rupture an irregular gray surface is exposed, and the ulcers resulting are shallow and painful. After a few days the exudation softens, and the points become denuded of epithelium, presenting superficial, painful ulcers, but without indurated edges. After an existence of one or two weeks the aphthæ disappear, leaving red spots, which, however, soon fade. Besides being very painful to the touch, and also to foods and liquids, they are attended with an increased secretion of saliva.

Two or more of the ulcers may coalesce, forming one large ulcerated

patch, to the edges of which vegetable fungi may adhere; in rare cases, it may become gangrenous, when the affection is usually complicated with gastro-intestinal disease. The constitutional symptoms are generally slight, except when there is a tendency to gangrene, which may cause a feeble pulse, pallid countenance, wasted body and limbs, and great prostration.

The causes of aphthous stomatitis may be bad hygienic conditions, uncleanness, and privation, but is usually owing to some derangement of the digestive organs, when it may also be accompanied with diarrhea. It differs from ulcerous stomatitis in form of the aphthæ, and the inflammation being confined to the immediate vicinity of the ulcers, and not extending over the mouth.

The treatment of aphthæ consists in the application of demulcent drinks, such as the mucilage of gum acacia, flaxseed, or marsh-mallow. Mel-boracis, honey of borax, is an efficient application applied with a camel's-hair pencil, and a small quantity of some opiate to relieve the tenderness of the ulcers and the restlessness. When the ulcers, besides being painful, are not disposed to heal, they may be touched with nitrate of silver or with hydrochloric acid in honey of roses, or nitric acid applied on the sharpened end of a stick of orange wood. The application of chlorate of potassium is also effective in some cases. The constitutional treatment consists in the administration of citrate of magnesia or rhubarb to correct the intestinal trouble, and tonics of sulphate of quinin or other vegetable bitters, or of the tincture of the chlorid of iron, to keep up the strength. When there is a great number of the ulcers, with considerable fever, and symptoms of cerebral congestion or of convulsions, the administration of laxatives and the bromids, with a warm foot-bath, will prove beneficial.

Thrush.—This affection, also known as “sprue” and “muguet,” is characterized by a form of inflammation which consists of points and patches of a curd-like appearance on the surface of the mucous membrane of the mouth, its common seat, as the fauces, pharynx, and esophagus are only occasionally affected.

Thrush commences as simple inflammation of the mucous surface, which is followed by the appearance of minute semi-transparent points or granules, which soon become white and opaque. While some remain as points, others extend, and by coalescing form patches, the surfaces of which are not uniform, but unequally elevated.

The central part of the points and patches project but little above the surrounding epithelial surface, being not more than a line in height. They resemble in color and consistence portions of curdled

milk, for which they may be mistaken. Being very easily detached, they are rapidly reproduced, and their white color may change to a yellow hue.

Composed of epithelial cells and a parasitic vegetable growth, of the *oïdium albicans* variety, each point consists of roots, branches, and sporules, the roots being transparent, and penetrating the epithelial layer, and sometimes even as far as the basement membrane. The branches divide and subdivide, and consist of elongated cells with one or two nuclei. Around the branches are numerous sporules. Thrush, in its mildest form, appears in points or small patches; and if the patches are of large extent, which, however, rarely occurs, the affection is attended by a state of great prostration and danger from some concomitant disease. Often it occurs as the sequel of pneumonia or gastro-intestinal inflammation, in the latter case being caused by neglect, improper food, or a deprivation of the maternal milk. In the mildest cases the symptoms are similar to those of simple stomatitis. When the inflammation is more extensive, and especially if the fauces and esophagus are involved, the inflamed surface becomes very hot, red, and painful, and there is fretfulness and fever. In the severest forms, the surface becomes dry and parched, the inflammation more extensive, and there is thirst, loss of appetite, vomiting, and frequently diarrhea, with an anxious, pallid countenance, rapid emaciation, and extreme prostration.

When thrush is complicated with aphthæ, small, white, flocculent patches appear on the surface of the mucous membrane, which increase in size and finally coalesce. In such patches some form of vegetable parasite exists, more commonly that known as *oïdium albicans*.

The causes of thrush are bad hygienic conditions, constitutional feebleness, indigestion, and improper food. It is common among emaciated children in crowded institutions, or where there is exposure to dampness. Foul nursing-bottles are also a common cause of this affection. It appears to be more prevalent during the summer months, and to occur more frequently under the age of three months.

Even children of eighteen months, suffering from debilitating diseases, are subject to it. The stools are greenish and acrid, giving rise to excoriations of the parts with which they come in contact. When this disease occurs in adults, it is attended with an increased flow of saliva and a dry, hot state of the mouth, rendering deglutition painful.

The treatment of thrush should commence with an improvement in the diet and locality, if these are at fault, and the administration of

an alkali to correct the acidity of the secretions which is usually present. Saccharate of lime added to the milk is very beneficial. The following combination is recommended by Dr. Sudduth:—

R. Infusi rhei, ℥ iij.
 Potassi bicarb., ℥ j.
 Tincturæ cinnamomi, ℥ ij.
 Syrupi simp., ℥ vj. M.
 Dose. A teaspoonful every three hours for an adult.

Quinin in one-grain doses every three hours will prove beneficial for infants. The quinin may be combined with tincture of the chlorid of iron to produce a tonic effect, one dram of the quinin with one ounce of the iron, in doses of fifteen drops every three hours. Dr. Trousseau recommends the following alterative tonic, which is very effective:—

R. Hydrarg. chloridi corrosivi, gr. j-ij.
 Liq. arsenici chloridi, f ℥ j.
 Tinct. ferri chloridi,
 Acid. hydrochlorici dil., āā f ℥ iv.
 Syrupi, f ℥ iij.
 Aquam, ad . . f ℥ vj. M.
 Dose. One dessertspoonful in a wineglassful of water after each meal.

The local treatment consists in the application of borax with honey—mel-boracis—or borax with powdered sugar, or dissolved in water. Some object to the use of sugar, as it promotes the growth of the parasite. Prof. J. L. Miller recommends the following:—

R. Sodii borat., ℥ j.
 Glycerinæ, ℥ ij.
 Aquæ, ℥ vj. M.
 SIG.—To be applied with a camel's-hair pencil four or five times a day.

If such an application fails, which is rarely the case, then recourse must be had to a solution of nitrate of silver or sulphate of zinc.

R. Zinci sulph., gr. ij-iv.
 Aquæ rosæ, ℥ ij. M.

When thrush is complicated with other diseases, the proper treatment for such diseases may render its treatment easy and effectual.

Gangrene of the Mouth.—This disease, characterized by such names as “Cancrum Oris,” “Gangrenopsis,” “Canker of the Mouth,” “Water Canker,” is common to children of debilitated constitutions and a decided lymphatic temperament, the result of scanty nourishment, improper clothing, and damp, unhealthy places of abode, or

where many children are crowded together in charitable institutions. There are several forms of this affection, the most common, perhaps, being preceded by inflammation of the gums, with such premonitory symptoms as great languor and listlessness, indisposition to any exercise, irritable temper, loss of sleep and appetite, and increase of thirst. The countenance becomes pale and dejected, and a peculiar puckering of the cheeks is observed about the corners of the mouth. Emaciation and night-sweats are not uncommon.

These premonitory symptoms may continue for several days, or even weeks, when an acute pain is felt in the mouth and gums, with a sense of heat and itching about their margins, the free edges of which become congested and thickened, spongy, and of a dark red or purple hue, bleeding readily.

The flow of saliva increases greatly, and is frequently mixed with blood. From about the necks of the teeth a muco-purulent matter is discharged, which after a time becomes thin, watery, and acrid, rendering the breath very offensive. In the majority of cases this disease is confined to one side of the mouth and to the lower jaw, and if allowed to progress, the gums separate from the necks of the teeth and alveolar processes, and become ragged, flabby, and livid; the teeth on the affected side loosen, and at length drop out, and at this stage there is an increase of the febrile symptoms and night-sweats. In such a state the gums may continue for weeks or even months, but usually after a few days a number of ash-colored vesicles make their appearance, which rapidly increase in size and become confluent, the divided gum presenting a gangrenous appearance. The dead portions separate, a gangrenous ulcer follows, and soon the entire part is destroyed and the inferior maxillary bone exposed. The ulceration is more common to the labial surface than to the lingual, and commences in the front part of the mouth, extending to posterior parts. The ulcers, before becoming gangrenous, are covered with a yellow or gray secretion, which, on being removed, exposes many small, red papillæ, which correspond to imperfect granulations. After a time the gangrenous ulceration extends to the mucous membrane of the cheek and lips, causing pain and difficulty in attempting to open the mouth, which is sometimes impossible.

In a short time the whole of the mouth becomes affected, and death usually occurs at about the eighth or, at the furthest, upon the fourteenth day from the commencement of the gangrene.

Mr. Tomes remarks that although the disease is usually confined to children during the shedding of the temporary teeth, yet adults are not wholly exempt from its attacks.

There is another form of this disease which differs considerably

from that just described, from the fact that it is not preceded by inflammation of the gums, but commences in the cheek, usually at the angle of the lips, and comes on abruptly, without the premonitory symptoms characteristic of the first form described.

There is first seen a hard, indolent tumor, about the size of an almond, in some part of the lips or cheek, which is deeply seated, the skin covering it being somewhat redder than natural. This tumor gradually increases in size for a few days, when the mucous membrane covering it presents a gangrenous appearance, with an offensive odor. Before this occurs, however, the external redness of the skin covering the tumor becomes pale, then livid, then of a grayish hue, surrounded by a red circle, which spreads rapidly and in a few hours changes to a black color.

The gums nearest to this tumor then become gangrenous, and the teeth loosen and at length fall out. Death usually occurs before the death of the bone of the jaw. There is also a superficial form of gangrene sometimes met with in the form of spots of a dark-brown color surrounded by a red margin, which vary in size, and have for their seat the corners of the lips and inner surfaces of the cheeks. These spots may first appear in the form of slightly reddened patches, but in this mild form are always superficial, confined to the mucous membrane alone, the sloughs separating with little loss of substance, soon to be followed by healthy granulations and cicatrization.

Gangrene of the mouth may occur at any period between the first and tenth year of age, but is more common between the second and fourth years; and the children subject to it are those of a lymphatic temperament, delicate constitution, soft, flaccid muscles, pale skin, and whose digestive organs are deranged. It usually occurs in those whose systems are much reduced or cachectic, and is more common to children crowded together in asylums and those deprived of pure air and proper nourishment, or enfeebled by disease. It sometimes follows the eruptive fevers, and such diseases as pneumonia, scrofula, whooping-cough, typhus fever, ague, etc.

In the treatment of gangrene of the mouth no little depends upon the time this is instituted. Before the gangrene makes its appearance much may be done in the way of preventive treatment, in order to remove the existing predisposition. A dry, pure air, cleanliness, and a nourishing diet adapted to the condition of the digestive organs are very essential. The preparations of iron and bitter vegetable tonics are required.

The administration of the sulphate of quinin, and the local application of a strong decoction of white oak bark, is thought, by Dr. Condie, to be beneficial in preventing gangrene of the mouth in cases

in which there is every reason to anticipate its speedy occurrence. For local treatment solution of sulphate of zinc (one dram to the ounce of water), to which is added honey and tincture of myrrh, two drams of each, will prove serviceable. Nitrate of silver, either in the solid form or in solution, applied to the affected part, has been successfully employed in a large number of cases.

When the disease is established, the first indication in the local treatment is to arrest the progress of the gangrene and hasten the detachment of the slough, and for such purposes highly stimulating or escharotic agents are required. The affected parts should be well cleansed, and then sprayed with carbolized water and strong acetic, sulphuric, nitric, or hydrochloric acids, nitrate of silver, acid nitrate of mercury, or chlorid of antimony, applied, by means of a brush, on and about the slough, to be at once followed by the application of dry chlorid of lime, when the mouth is to be thoroughly washed out with water, by means of a syringe. By such applications to the edges of the ulcers, the diseased tissue is destroyed and healthy granulations promoted.

After the separation of the slough the escharotic is to be discontinued and the chlorid of lime alone employed. Some, however, prefer milder remedies than the strong acids, such as the nitrate of silver, if the slough is small in extent; if larger, muriated tincture of iron is applied, undiluted, and after the progress of the gangrene is arrested the use of astringent stimulants, such as tincture of myrrh or the French aromatic wine.

Dr. Coates found sulphate of copper, according to the following formula, to be successful:—

R.	Cupri sulph.,	ʒij.	
	Pulv. cinchonæ,	ʒss.	
	Aquæ,	ʒiv.	M.

To be applied twice a day to the entire ulcerations and excoriations.

In milder cases a solution of sulphate of zinc, ʒj to an ounce of water, by itself or combined with tincture of myrrh, is found to be useful. If the milder agents, after two or three days' use, do not prevent the gangrene from spreading, strong hydrochloric acid, applied by a camel's-hair pencil, may prove efficacious, and its use immediately followed by lime-water made turbid by lime. To correct the fetor, chlorin or carbolic acid, properly diluted, may be employed alternately with the sulphate of copper, or Labarraque's solution of chlorinated soda, one part to eight or ten parts of water. The tincture of myrrh, with tonics and a nutritious diet, should complete the treatment.

Dr. Condie recommends the administration of sulphate of quinin during the time the local remedies are being applied, as follows:—

℞. Quiniae sulphat.,	gr. x.	
Acid. sulph. dil.,	℥x.	
Sacch. alb.,	ʒiv.	
Aq. cinnamom.,	ʒiv.	M.

Dose : A teaspoonful every three hours.

The free internal use of the chlorate of potassa, one to three scruples in twelve hours, according to the age of the child, has been employed with advantage.

For the diarrhea accompanying the disease, and especially when it is profuse, Dr. Condie recommends acetate of lead, as follows:—

℞. Acetat. plumbi,	gr. xvj.	
Cretæ præp.,	ʒiiss.	
Ipecacuanhæ,	gr. iv.	
Opii pulv.,	gr. ij.	M.

To be divided in xvj portions ; one to be given every three or four hours.

Syphilitic Ulceration of the Mouth.—Syphilitic ulcers are the secondary results of constitutional syphilis, and are usually found on the tongue, the lips, or the tonsils. Although the syphilitic ulcer is usually superficial, little irritating, and attended with the discharge of a small amount of pus, it is occasionally phagedenic in character. Such ulcers, as a result of constitutional syphilis, may be incited by abrasions and injuries caused by fractured and carious teeth upon the sides of the tongue, and they may appear on the lip as the result of kissing. These ulcers also appear upon the tonsils and pharynx. These syphilitic ulcers may be distinguished from more malignant ones by their improvement under specific medication and the other indications of constitutional syphilis generally present and recognizable. The glands of the neck are often found enlarged when syphilitic ulcers exist in the mouth or on the lips. Local and constitutional treatment is required in the majority of cases. The local treatment consists in the application of a solution of chromic acid—ten grains to the ounce of water—by means of a camel's-hair brush, three times a day. When such applications fail, the administration of mercury is necessary ; and in all cases a total abstinence from alcoholic drinks and tobacco is required.

Mercurial Stomatitis.—The employment of mercury as a medicinal agent causes increased watery evacuations, increased flow of bile and saliva, and, as a consequence, increases the flow of blood to the secreting part. But when administered in excess other effects follow. It is

capable of producing inflammation, especially the acute, phlegmonous, adhesive variety. The effects of its use depend upon the quantity administered and the susceptibility of the patient to its action. When carried to excess, the mucous membrane of the mouth becomes tender, red, and swollen, the glands beneath the jaw become painful, and at length ulceration occurs, which spreads from the gums—where the effects of the drug are first observed—to fauces and throat, and, in extreme cases, the parts affected may perish.

Prof. Wood describes the disease as follows: “ Among the first indications of the action of mercury are often a metallic taste in the mouth, like that of brass or copper, and some increase of saliva. At the same time a close examination will detect a slight redness and swelling of the gums, particularly about the necks of the lower incisors, while somewhat below their edge a broad, white line may be observed, depending on opacity of the epithelium.

“ The patient soon begins to feel some uneasiness, complaining of soreness when the gums are pressed, and of pain when the teeth are forcibly closed together. There is also a sense of stiffness about the jaws when the mouth is opened, and they feel as if projecting above their proper level. The flow of saliva increases, the inflammation extends, the gums and palate become obviously swollen, and the tongue covers itself with a yellowish-white or brownish fur, and is often so much enlarged as to exhibit the impression of the teeth upon being projected from the mouth. The throat frequently becomes sore, and the cheeks and salivary and absorbent glands swollen and painful. There is often severe toothache or pain in the jaws. A whitish exudation along the edges of the gums is very common.

“ The breath, which sometimes from the beginning, and sometimes even before the appearance of any one of the symptoms mentioned, has a peculiar, disagreeable odor, now becomes extremely offensive, and in bad cases almost intolerable. Ulceration often occurs, especially about the necks of the teeth, which are consequently loosened, and in the cheeks, lips, and fauces. The ulcers often have their origin in a vesicular eruption. The whole mouth with its appendages is sometimes so swollen that it can scarcely be opened, and the tongue so much enlarged as to project beyond the lips.

“ The patient is now nearly or quite unable to articulate or to masticate his food, and sometimes can scarcely swallow. Hemorrhage is not an unfrequent attendant upon the bad cases, and is sometimes so profuse as to be alarming. Sloughing also takes place, and portions of the jawbone are occasionally laid bare. There is always in the severe cases more or less fever, which is partly symptomatic of the local affection and partly the direct effect of the mercury. Death, from

the exhausting influence of the irritation, want of nourishment, and hemorrhage, has occurred in numerous instances, but the patient usually recovers from the worst forms of the affection, though sometimes with a deformed mouth.

“The tongue and cheeks have occasionally adhered at points where their ulcerated surfaces were in contact, and a surgical operation has been necessary to remove the evil.”

For the treatment of mercurial stomatitis, see “Treatment of Mercurial Inflammation of the Gums.”

Scurvy-Scorbutus is a disease characterized by spongy gums, offensive breath, livid spots on the skin, great general debility, and a pale, bloated countenance.

“Scurvy,” remarks Prof. Wood, “is generally very gradual in its approach, so that it is scarcely possible to say, in any particular case, what was its precise time of attack. Attention is commonly first attracted by an unhealthy paleness of complexion, a feeling, on the part of the patient, of languor and despondency, with an indisposition to bodily action, and unusual fatigue after exercise; a sensation of weariness and aching in the limbs, as from over-exertion, though the patient may have been at rest; and some swelling, redness, and tenderness of the gums, with a tendency to bleed from slight causes. With the advance of the disease, the face becomes paler, and assumes a somewhat sallow or dusky hue, and often a degree of puffiness; the lips and tongue become pallid and contrast strikingly with the gums, which are purple or livid, especially at their edges, rise up between and around the teeth, are soft and spongy, and bleed from the slightest touch; the breath is offensive; purplish spots or blotches appear upon various parts of the surface, beginning usually upon the lower extremities, and afterward extending to the trunk, arms, and neck, though seldom affecting the face; hemorrhage frequently occurs, most commonly from the nose, gums, and mouth, but sometimes from the stomach, bowels, and urinary passages; the feet become edematous and the legs swollen and painful; the general debility increases, and muscular exertion is apt to be attended with palpitation of the heart, panting, vertigo, dizziness, and a feeling of faintness. The petechial spots are evidently owing to the extravasation of blood within the cutaneous tissue. Occasionally portions of the surface look as if bruised without having suffered any violence; and blows which, under ordinary circumstances, would produce no effect, now give rise to extensive ecchymosis. Should the disease continue, all the symptoms become aggravated; the complexion assumes often, with its paleness, a livid or leaden hue; the gums swell greatly, and put forth a blackish, fungous growth, so as sometimes to conceal the teeth; blood con-

tinually oozes from them ; sloughing occasionally takes place, laying bare the necks of the teeth, and extending, in very bad cases, even to the cheek.

“The teeth become loose and sometimes fall out ; the patient is unable to chew solid food, in consequence of the state of his gums. The breath becomes intolerably offensive ; hard and painful tumefactions occur in the calves of the leg, among the muscles of the thigh, upon the tibiæ and lower jaw, and in the hand, with stiffness and contraction of the joints, especially the knee, and severe pain in the extremities upon every attempt at movement ; and the debility, before so prominent a feature in the case, now becomes excessive, so that the least exertion is dangerous, and the patient sometimes dies suddenly upon rising from bed or upon being conveyed, without great caution, from one place to another. Wounds, even slight scratches, degenerate into unhealthy ulcers ; old cicatrices break out afresh, and existing ulcers assume a new and much worse aspect. The bones are said to be softened, united fractures are again opened, and in the young the epiphyses separate sometimes from the shaft.

“Throughout the complaint the tongue is usually clean and moist ; and the appetite and digestion remain unimpaired almost to the last, unless the disease, as sometimes happens, should be complicated with fever. Indeed, there is often a craving for food, especially for fresh vegetables and fruits ; occasionally, however, there is vomiting, with epigastric distress and other evidences of stomachic disorder. The bowels are mostly costive, and in some cases obstinately so, but diarrhea not unfrequently intervenes, with black or bloody and offensive evacuations. The pulse is generally small, feeble, and slow ; but cases occur in which it becomes very frequent, and the surface of the skin febrile, probably from the sympathy of the system with various local irritative congestions.

“Great emaciation usually attends the disease when severe or lasting, but not invariably. Little cerebral disturbance is ordinarily observable, and the patient often retains full possession of his senses and intellect to the last.”

In regard to the cause of scurvy, it is the general belief that it results from the absence of fresh vegetables and fruits. Prof. Hamilton says : “In regard to the pathology of scurvy, the belief prevails that it is due essentially to the absence of certain staminal principles from the blood, and especially potash, as all, or nearly all, the remedies which have been employed successfully in the prevention or cure of scurvy contain potash, such as potatoes, cabbage, celery, lettuce, lime, lemon, and orange juice.” As regards the treatment, both local

and constitutional are required. The local treatment, being the same as is recommended for "Mercurial Stomatitis," need not be repeated. The constitutional treatment consists in the administration of the vegetable acids, such as lemonade, for example. Turner's antidote, composed of potassæ nitratis ℥ij, and acidi acetici ℥viij, in tablespoonful doses, three times a day, is a favorite remedy. In connection with this, Dr. Garretson recommends saturating a sheet with water moderately warm and moderately salt, which is thrown around the body each morning immediately on rising, and rubbed against the flesh until a ruddy glow is excited.

CHAPTER IV.

DISEASES OF THE GUMS.

THE gums frequently assume various morbid conditions, but as many of the lesions which affect the oral mucous membrane have been described under "Diseases of the Oral Mucous Membrane," it will only be necessary to refer to such affections as are confined to the gums.

The diseases of the gums are divided into two classes: those which are the result of local irritation, and those which arise from constitutional causes.

Were it not for local irritation in these parts, the constitutional tendencies to disease would rarely manifest themselves; and, on the other hand, were it not for constitutional tendencies, the effects of local irritation would seldom be of a serious character.

Each constitution has its peculiar tendency; or, in other words, is more favorable to the development of some form of disease than others; and this tendency is always increased or diminished according to the healthy or unhealthy performance of the functional operations of the body generally. Thus, derangement of the digestive organs increases the tendency, in an individual of a mucous habit, to certain forms of diseased action in particular organs, and especially in the gums. A local irritant, which would otherwise produce only a slight inflammation of the margins of the gums, would now give rise to turgidity and sponginess of their whole structure. The same may be said with regard to a person of a scrofulous or scorbutic habit.

The susceptibility of the gums to the action of morbid irritants is always increased by enfeeblement of the vital powers of the body. Hence, persons laboring under excessive grief, melancholy, or any other affection of the mind, or under constitutional disease tending to

enervate the vital energies of the system, are exceedingly subject to inflammation, sponginess, and ulceration of the gums. But, notwithstanding the increase of susceptibility which the gums derive from certain constitutional causes and states of the general health, these influences may, in the majority of cases, be counteracted by a strict observance of the rules of dental hygiene; or, in other words, by constant and regular attention to the cleanliness of the teeth.

A local disease, situated in a remote part, often has the effect of diminishing the tendency in the gums to disease; but when, from its violence or long continuance, the general health becomes implicated, the susceptibility of these parts is augmented.

Although deriving their predisposition to disease from a specific, morbid constitutional tendency, they, nevertheless, when diseased, contribute in no small degree to derange the whole organism. Their unhealthy action vitiates the fluids of the mouth and renders them unfit for the purposes for which they are designed; hence, when these parts are restored to health, whether from the loss of diseased teeth or the treatment to which they may have been subjected, the condition of the general health is always immediately improved.

Thus, while the susceptibility of the gums to morbid impressions is influenced by the state of the general health, the latter is equally influenced by the condition of the former. And not only is a healthy condition of the gums essential to the general health, but it is also essential to the health of the teeth and alveolar processes. From the intimate relation that subsists between the former and the latter, disease cannot exist in one without in some degree affecting the other. Caries of the teeth, for example, often gives rise to inflammation of the gums and periodontal membrane; on the other hand, inflammation of these parts vitiates the fluids of the mouth and causes them to exert a deleterious action upon the teeth, and also excites more or less constitutional derangement.

The gums appear bloodless and pale in general anemia, or chlorosis; also edematous as a result of catarrhal stomatitis, or after typhoid fever, or during pregnancy. The gums also become hyperemic, assuming a bluish-red color, and bleeding from the slightest injury, a condition which may also arise during pregnancy, or result from mercurial poisoning, or exposure to the irritating action of acids and other poisons.

INFLAMMATION OF THE GUMS.—ULITIS.

Acute inflammation of the gums frequently occurs in connection with stomatitis, or general inflammation of the mucous membrane of the buccal cavity, which appears under a great variety of forms. In this case the inflammatory action does not always extend to the sub-

jacent fibro-cartilaginous structure ; but the local disease is often complicated with other disorders, the treatment of which comes more properly within the province of the medical than that of the dental practitioner. Ulitis, or acute inflammation of the gums, is, in most cases, a purely local disease, arising from mechanical injury, such as the irritation of artificial teeth, etc. Other common causes are the accumulation of salivary calculus on the necks of teeth, decomposing particles of food at the borders of the gums and in the space between the gum and the neck of the tooth, and the accumulation of micro-organisms. Ulitis also arises from the presence of carious, dead, loose teeth, and teeth irregularly placed. When the gums are in contact with, or overlap the edges of carious cavities, they become irritated and inflamed, and in many instances protrude into such cavities in the form of lobulated tumors of such a size as to more or less fill up the cavity. A vitiated condition of the fluids of the mouth will also cause ulitis ; it may also arise from the irritation of dentition or as a consequence of periodontitis. It often extends to the submaxillary glands and muscles of the face, and is attended by swelling and other morbid phenomena. But as this form of inflammation of the gums is treated of in connection with Stomatitis, it will not be necessary to repeat what we have said elsewhere concerning it.

The chronic form of ulitis may exist for years without being attended with suppuration or recession of their margins from the necks of the teeth ; but these phenomena are sooner or later developed, according to the amount of local irritation and the state of the constitutional health and habit of the body. With the occurrence of inflammation the margins of the gums gradually lose their festooned appearance, become thick, spongy, and rounded, and ultimately, on being pressed, purulent matter is discharged from between them and the necks of the teeth. Their sensibility is increased and they bleed from the most trifling injury.

The diseased action usually first develops itself in the gums around the lower front teeth and the upper molars, opposite the mouths of the salivary ducts, also in the immediate vicinity of aching, decayed, dead, loose, or irregularly arranged teeth, or in the neighborhood of roots of teeth ; from thence it extends to the other teeth. The rapidity of its progress depends on the age, state of the general health, temperament and habit of body of the individual, and the character of the local irritant which has given rise to it. It is always more rapid in persons addicted to the free use of spirituous liquors, and in individuals in whom there exists a scorbutic tendency, or who have suffered from venereal disease, or from the constitutional effects of a mercurial treatment used to cure this or other diseases.

The inflammation may be confined to the gums of two or three teeth, or it may extend to the gums of all the teeth in one or both jaws.

As the disease advances, the gums begin to recede from the necks of the teeth, and the alveoli to waste, and the teeth, as they lose their support, loosen and ultimately drop out. In Fig. 118 is represented a case in which nearly one-half of the roots of the lower incisors have become exposed by this devastating process.

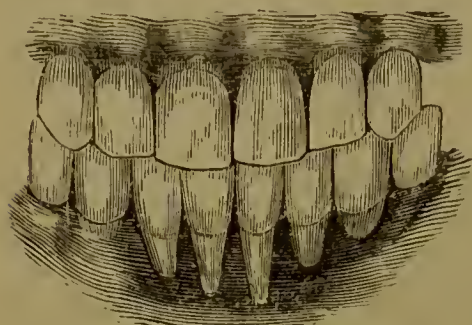


FIG. 118.

But the loss of the teeth, though it puts a stop to the local disease, is not the only bad effect that results from it. Constitutional symp-

toms often supervene, more vital organs become implicated, and the health of the general system is sometimes very seriously impaired. Hence, the improvement often observed after the loss of the teeth in the general health of persons whose mouths have for a long time been affected with this disease.

The loss of the teeth, from the wasting of the gums and alveolar processes, although occurring frequently in advanced life, is not a necessary consequence of senility, for we occasionally see persons of seventy, and even eighty years of age, whose teeth are as firmly fixed in their sockets, and their gums as little impaired, as in individuals at twenty. But it is of little importance whether it be the result of old age, a constitutional tendency, functional derangement of some other part, or local irritation, since the consequences resulting from such loss are always the same.

The gums, after having been once the seat of chronic inflammation, are ever after more susceptible to the action of morbid irritants.

In scrofulous diatheses, the gums, instead of being purple and swollen, may become pale and harder than ordinary, and, on being pressed, discharge muco-purulent matter of a dingy white color. They often remain in this condition for years without appearing to undergo any structural alteration or to affect the alveolar processes. It rarely occurs before the age of eighteen or twenty, and it seems to be the result of impaired nutrition. The gums exhibit no signs of inflammatory action; on the contrary, they are paler, less sensitive, and possess less warmth than usual. It is never attended with tumefaction or absorption, except in its advanced stages.

Treatment.—In the treatment of ulitis, the first thing claiming the attention is the removal of the exciting causes. If there are dead or

loose teeth in the mouth, or teeth which, from their position, act as mechanical irritants, they should be at once extracted. The remaining teeth should, at the same time, be freed from salivary calculus and all other irritating depositions, in such a thorough manner as to permit none to remain, either about the necks or beneath the margins of the gums; and, if necessary, all deposits should be removed from about the very ends of the roots of the teeth, so far, at least, as the separation of the gums from the teeth extends. All necrosed portions of process should also be removed, and the entire surfaces of the exposed portions of the roots of the teeth be well polished. Besides removing the tartar, if the gums are much congested they should be scarified around the necks of the teeth and all hypertrophied growths in the interstices cut away. The bleeding which follows such operations should be promoted by frequently rinsing the mouth with warm water.

It is essential, in the treatment of the disease under consideration, that a decided impression be made upon it at once; consequently, no time should be lost in the removal of local exciting causes.

Several sittings are often required for the complete removal of calcic deposits when present.

The cure may be hastened by washing the mouth several times a day with some tonic and astringent lotion. The author has found combinations of powd. nutgalls, cinchona, and orris root in infusion of roses, to be very serviceable; also as gargles, combinations of chlorate of potassium and borax, in water; also, tannic acid, chlorate of potassium, with honey of roses and water; also, tinct. of capsicum, cologne water, borax, tinct. of cinchona, and tincture of pyrethrum with water. When there is much soreness, a combination of borax, honey and sage tea will prove soothing and healing.

The pleasantest, and at the same time the most efficacious, mouth-wash which the author has ever employed is the following:—

℞. South American soap bark,	8 ounces.
Pyrethrum, }	
Orris root, }	
Benzoic acid, }	. . . . . each 1 ounce.
Cinnamon, }	
Tannic acid,	4 drachms.
Borax,	4 scruples.
Oil of wintergreen,	2 fluidrachms.
Oil of peppermint,	4 “
Cochineal,	3 drachms.
White sugar,	1 pound.
Alcohol,	3 pints.
Pure water,	5 “
Mix ingredients thoroughly, digest for six days, and filter.	

The following combinations are also serviceable :—

R.	Acid carbolic,	gtt. v.	
	Glycerini,	℥j.	
	Ol. caryophylli,	gtt. v.	M.
R.	Sodæ sulphis,	℥j.	
	Glycerini,	℥j.	M.
R.	Acid carbolic,	℥ss.	
	Glycerini,	℥xv.	M.
R.	Sodæ boras.	℥ij.	
	Glycerini,	℥j.	
	Aquæ,	℥iv.	M.

In mild cases of inflammation of the gums and mucous membrane of the mouth, iodine in glycerin—saturated solution—is an excellent application.

For ulceration of the gums and mucous membrane of the mouth see “Ulcerous Stomatitis.”

For soft, swollen, and spongy gums, the French preparation known as *Phénol Sodique*—phenate of soda—a teaspoonful to a tumbler of water, will prove beneficial.

If, notwithstanding the use of the means here recommended, matter still be discharged from around the necks of the teeth, and should the gums continue spongy and manifest no disposition to heal, their edges may be touched with a solution of the chlorid of zinc or nitrate of silver. This will seldom fail to impart to them a healthy action. Either remedy may be used in the proportion of from one to three, or even six grains to one ounce of water. The most convenient mode of applying them, is with a camel's-hair pencil, and they will often succeed when other remedies fail. In those cases where the matter discharged from the edge of the gum has a nauseating and disagreeable odor, a preparation composed of carbolic acid ℥ij; oil of gaultheria, ℥ij, and aqua rosæ, ℥iij, of which ten to twenty drops may be added to a wineglass of water and used as a gargle, or applied on lint to the inflamed surface, is an excellent remedy for rendering the mouth comfortable. An excellent disinfectant in such cases is a gargle made by diluting a teaspoonful of chlorinated soda (Labarraque's solution) in four or eight ounces of water. Or it may be used much stronger, and applied with a small mop to the diseased parts; phénol sodique is also an excellent disinfectant.

While the means here directed for the cure of the disease are being employed, a recurrence of its exciting causes must be studiously guarded against. Tartar and foreign matter of every kind should be

prevented from accumulating on the teeth, by a free and frequent use of a suitable brush and waxed floss-silk, until a healthy action be imparted to the gums; these should be used at least five times a day—immediately after rising in the morning, after each meal, and before retiring at night. The application of the brush may at first occasion some pain; but its use should nevertheless be persisted in, for, without it, all the other remedies will be of little avail. The friction produced by it, besides keeping the teeth clean, is of great service to the gums, in imparting to them a healthy action.

The treatment necessary in that form of disease which we noticed as being characterized by preternatural paleness and discharge of muco-purulent matter from between the edge of the gum and the neck of the tooth, consists of the use of tonics, free exercise in the open air, and the application to the edges of the gums of nitrate of silver, followed by the daily use of an astringent mouth-wash.

HYPERTROPHY, OR MORBID GROWTH OF THE GUMS.

The structural changes which take place in the gums as a consequence of increased vascular action are almost as various as are the constitutional tendencies of different individuals. The affection of which we are now about to treat is characterized by a morbid growth, which is sometimes so considerable that it almost covers the crowns of the teeth, thus interfering very seriously with the function of mastication. When thus affected, the gums have a dark purple color, with thick, smooth, and rounded margins, and discharge almost constantly from their inner surface, a thin, purulent matter, which exhales an exceedingly offensive odor. They bleed profusely from the slightest injury, and are so sensitive that the pressure even of the lips is sometimes attended with pain. They are also affected with a peculiar itching sensation, which at times is a source of great annoyance. Microscopic investigation shows the fibrous stroma of the gum tissue to be unduly increased, but without the presence of any new glandular or epithelial elements.

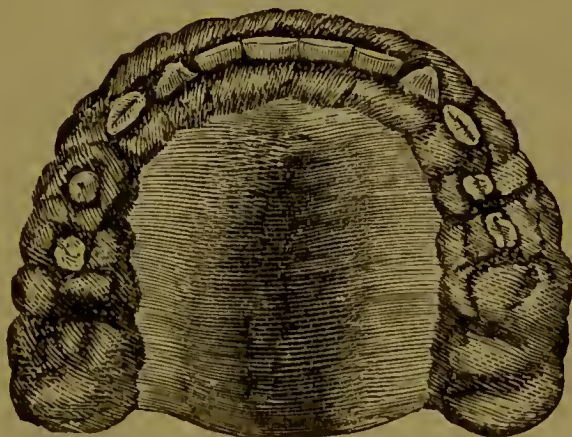


FIG. 119.

The accompanying engraving (Fig. 119) will convey to the reader a more correct idea of the appearance of the gums when thus affected, than any description which can be given. It will be perceived from

this that the morbid growth extends to the gums of all the teeth, as it usually does in this variety of diseased action.

Among the local and constitutional effects arising from the disease are offensive breath, vitiated saliva, destruction of the alveoli, with loosening and ultimate loss of the teeth, impaired digestion, with all its disagreeable concomitants, enlargement of the tonsils and bronchitis, together with a long train of other phenomena.

Causes.—The exciting cause of this peculiar affection is local irritation, produced by salivary calculus, dead, diseased, or irregularly arranged teeth; but the character of the structural alteration is evidently determined by some cachectic habit of body or constitutional tendency. It often attacks the gums of individuals whose teeth are sound and well arranged; but the author has never met with a case in which salivary calculus was not present, though in some instances the quantity was so small as almost to lead one to doubt whether it could have had much agency in the production of the disease. But the susceptibility of the gums to morbid impressions in individuals liable to this affection is usually so great that an irritant which under other circumstances would scarcely excite an increase of vascular action, gives rise, in cases of this sort, to the rapid development of an aggravated form of disease.

Treatment.—The first thing to be attended to in the treatment of this disease is the removal of all dead teeth, and such others as may in any way irritate the gums. The morbid growth should be next removed by making a horizontal incision entirely through the diseased gums to the crowns of the teeth. This should be carried as far back as the morbid growth extends. After this the gums should be freely scarified by passing a lancet between the teeth down to the alveoli, in order that the vessels may be completely divided and discharge their accumulated blood. This should be repeated several times, at intervals of four or five days. Meanwhile the mouth may be washed three or four times a day with some astringent and detergent lotion, and occasionally mopped with a weak solution of chlorid of zinc or nitrate of silver, one grain to the ounce of water. Phenol sodique—phenate of soda—either in its full strength or diluted with from one to twelve times its bulk of water, according to indications, proves very serviceable as a lotion, causing the rapid absorption of the extravasated blood, preventing fetor, and speedily healing and hardening the gums. The salivary calculus should be removed as soon as the gums have sufficiently collapsed to admit of the operation.

In severe cases a permanent cure cannot be effected by the local treatment above described, for, in addition to the removal of the enlarged gum tissues, it may be necessary to excise the edge of the

alveolus, especially if there is necrosis of the margins present, or expansion of the alveolar border. Particular attention should be paid to the regimen of the patient and such general remedies prescribed as the peculiar nature of the case may indicate. Excess and intemperance of every kind must be avoided. In cases of an inflammatory type, the diet should be chiefly vegetable ; but where there is debility or other cachexia, animal food should be used, taking care to avoid all young meats, as veal or lamb, all gross meats, such as pork, and all salt meats or shell-fish. Fruits and acid beverages, such as infusions of malt and vinegar, lemon-juice, spruce beer, etc., may be used with advantage.

The teeth should be kept perfectly and constantly clean. Not a particle of foreign matter should be permitted to remain between them or along the edges of the gums. A scrupulous attention to this precaution is indispensably necessary, as it constitutes one of the most important remedial indications.

MERCURIAL INFLAMMATION OF THE GUMS.

Small and repeated doses of mercury, when carried to the point of salivation, frequently give rise to the development of peculiar morbid phenomena in the gums and other parts of the mouth. The first indication of the specific action of this powerful medicinal agent upon the animal economy consists in a slightly increased redness and tumefaction of the free edge of the gums, around the necks of the inferior incisors. There is a characteristic bluish color along the edge of the gums, while the investing mucous membrane of the adherent portion, a little lower down, often assumes a white color, owing to the opacity of the epithelium. These appearances are followed by increased secretion of saliva ; a strong metallic taste ; soreness of the teeth and gums ; inflammation and swelling of the mucous membrane of the roof of the mouth, fauces and cheeks, and the salivary glands ; a swelling of the tongue, with increased redness of its edges, and a peculiarly offensive odor of breath. In the meantime, the edges of the gums about the necks of the teeth swell and assume an increase of redness ; the saliva becomes viscid, and is secreted in such abundance as to flow from the mouth, and the movements of the jaws are attended with pain. The alveolo-dental periosteum is thickened, and the teeth raised from their sockets and loosened. A vesicular eruption sometimes appears, followed by ulceration and sloughing of the gums, and very frequently by necrosis of large portions of the alveolar process and maxilla. We were shown, a few years since, the entire alveolar border of both jaws, the necrosis and exfoliation of which had been occasioned by severe mercurial salivation ; and we have frequently had occasion to remove portions both of the superior and in-

ferior maxillary bones—the necrosis having been occasioned by the use of this medicine.

By the prudent administration of mercury, salivation may be induced without causing the deplorable effects just described. But the specific action of this agent upon the constitution is always attended by more or less tumefaction and sponginess of the gums, and when once brought under its influence, however perfectly its effects may have subsided, they are ever after more susceptible to morbid impressions. Again, it should be remembered that very many of these deplorable symptoms follow the use of mercurials, even where there is no intention to salivate. It is a powerful agent, capable of much good, but one which has been productive of untold mischief, especially upon the mouth and teeth. Doubtless life must be saved at the expense, if necessary, of the teeth; but the peculiar specific action of this medicine should forbid its constant and indiscriminate employment.

Treatment.—It is scarcely necessary to say, that until the use of the mercury is discontinued it will be impossible to control or even counteract its effects upon the gums; but in mild cases these usually soon disappear after the action which it has produced on the general system has completely subsided. When the gums continue spongy, the bowels should be kept open with Seidlitz powders or other saline cathartics, the patient restricted to a fluid farinaceous diet, and the mouth gargled several times a day with mild astringent lotions, to which it may sometimes be advisable to add a little laudanum. Benefit may be derived from the application of the official tincture of iodine in a solution composed of one-half water. For internal use chlorate of potash and iodide of potassium are considered the best remedies in mercurial poisoning.

The chlorate of potash is also of very great service as a lotion, in the strength of one dram to the ounce of water.

For internal use, ten grains of the chlorate of potash may be dissolved in half an ounce of water, and administered in four or five doses during the day. For an adult, Dr. Garretson recommends the following lotion as very beneficial in cases where the tumefaction is very great and indolent looking:—

R. Potassæ chloras,	ss.	
Sodæ boras,		
Alumen pulv.,	aa	ij.
Potass. permang.,		grs. xxv.
Aqua cologn.,		ss.
Tinct. cinchonæ,		ij.
Tinct. myrrhæ,		j.
Infus. quercus (fort.),		iv.
		M.

SIG. —Gargle the mouth pro re nata.

The iodid of potassium may be given in doses of from three to five grains, three times a day, in some bitter infusion; also, diluted sulphuric acid combined with bitter tonics; also the tincture of belladonna in five-drop doses three or four times daily.

The following gargle will be found very serviceable in mercurial salivation:—

R. Tinct. iodinii,	℥ iij to vj.
Potassæ iodidi,	grs. xv. to xxx.
Aquæ,	Oss. M.

Astringent washes of tannic acid, borax, or dilute alcohol, are also serviceable.

After the action of the medicine upon the system has subsided, and the disease assumes a chronic form, the use of astringent washes should be continued, and if there are any teeth which, from the loss of their vitality or from having become very much loosened by the partial destruction of their sockets, act as irritants they should be removed; but teeth should not be sacrificed merely on account of their loosened condition, as they may become firmly fixed on the subsidence of the disease.

For correcting the fetor arising from the ulcerated surfaces, a gargle may be used composed of two or three drams of charcoal suspended by agitation in a tumbler of water. After retaining a portion of this gargle for a short time, the mouth should be rinsed with warm water to remove the particles of charcoal.

A solution of the permanganate of potash, in the strength of from two to ten grains to the ounce of water, as a gargle, or of phenol sodique in the form of spray, will also prove effective for the removal of the fetor; also washes made from chlorinated soda or lime, and solutions of listerine or borine.

ULCERATION OF THE GUMS OF CHILDREN, ATTENDED WITH EXFOLIATION OF THE ALVEOLAR PROCESSES.

The gums and alveolar processes of children are occasionally attacked by a very peculiar form of disease, which occurs more frequently during the shedding of the temporary and the eruption of the permanent teeth than at any other period of childhood. We have never known adults to be affected with it, and to the ordinary spongy, inflamed, and ulcerated gums it does not appear to be at all analogous. It bears a much closer resemblance to *cancrum oris*, yet differs in many particulars from this disease.

Among the symptoms which characterize the affection are itching and ulceration of the gums and their separation from the necks of the

teeth and alveolar processes ; there is, at first, a discharge of mucopurulent matter from between the gums and necks of the teeth, which ultimately becomes ichorous and fetid. The teeth loosen, and the alveoli lose their vitality and exfoliate. Ulcers are formed in various parts of the mouth, and the gums and lips assume a deep red or purple color. In the exfoliation of the alveolar processes the temporary, and sometimes the crowns of the permanent teeth, are carried away. The constitutional symptoms are : skin, for the most part, dry ; pulse, small and quick ; the bowels generally constipated, though sometimes there is diarrhea ; and to these symptoms may be added lassitude and a disposition to sleep.

These may be regarded as the prominent phenomena of the disease in its most aggravated form. When exfoliation of the alveolar processes takes place, the symptoms usually abate, and sometimes wholly disappear.

In the majority of cases the disease is confined to one jaw and to one side, though sometimes both are affected by it. The effect on the permanent teeth, in all the cases which have fallen under the notice of the author, was injurious.

Causes.—The disease seems to be the result of general debility or defective nutrition and a cachectic habit of body. It appears to be almost wholly confined to children of the poor and destitute, and, so far as the author's observations extend, to those who reside in cellars or small and confined apartments. Children of scorbutic habit seem to be the most subject to it. From the great debility of all the organs of the body, their functions are languidly and imperfectly performed. That the disease is determined by general enfeeblement of the functions of the body there is, we think, little doubt ; but whether it would develop itself independently of any local cause, is a question which we do not feel ourselves able satisfactorily to answer. It is not at all improbable that local irritants are the exciting cause ; and we are the more inclined to this belief from the fact that in all the cases which have fallen under our observation the teeth were considerably decayed and had previously given rise to pain, and in some instances they were coated with tartar. While, therefore, the character of the affection is determined by some peculiar constitutional tendency and general enfeeblement of the vital powers of the body, it is not unlikely that local irritation is the immediate cause of its development.

Treatment.—The local treatment should consist of acidulated and astringent gargles. The ulcerated parts may be occasionally touched with a solution of the nitrate of silver, or chlorid of zinc, from three to eight grains to the ounce of water ; phenol sodique or permangan-

ate of potash solution may be employed to correct the fetor. As soon as the alveolar process exfoliates, it should be removed. After this takes place a cure is generally speedily effected under proper constitutional treatment. This last may consist of mild alteratives, a generous nutritive diet, consisting of succulent vegetables, and, in the absence of fever, of wholesome meats, tonics, and exercise in the open air. (See "Ulcerous Stomatitis.")

ADHESIONS OF THE GUMS TO THE CHEEKS.

The gums and inner walls of the cheeks sometimes contract adhesions which interfere seriously with the functions of the mouth. The affection may be congenital, but in the majority of cases it occurs subsequently to birth. The extent of the adhesion may be small, or it may occupy the gums of the entire alveolar border of one or both sides of the mouth and of one or both jaws. Desirabode relates the case of a young man, who, in consequence of a venereal ulcer, had his upper lip united to the gums of the four incisors in such a way as to form a sort of loop above the teeth, which, by the retraction of the lip, were caused to project outward.

Adhesion of the gums to the cheek or lips results from ulceration, caused either by constitutional disease or local lesions. But that it arises more frequently as a consequence of the immoderate use of mercury than from any other cause is a universally admitted fact. The author has met with several cases, however, in which the affection has resulted from ulceration of the gums around necrosed temporary teeth and of the corresponding wall of the cheek, caused by excoriation of the mucous membrane, produced by the sharp points of the protruding roots. But the extent of the adhesion, in cases of this sort, is never very considerable.

The proper remedy is to separate the parts which have grown together with a sharp bistoury. This done, reunion should be prevented by keeping a pledget of cotton or lint in the wound, until the process of cicatrization is completed.

CHAPTER V.

DISEASES OF THE PERIDENTAL MEMBRANE.

PERIODONTITIS.

PERIODONTITIS, pericementitis, alveolo-dental periostitis, periodentitis, as the affection is variously named, denotes inflammation of the investing or peridental membrane of the roots of the teeth, a tissue highly vascular and very susceptible to inflammatory conditions, and which may, in many cases, be regarded as a premonitory stage of alveolar abscess.

Although the death of the pulp generally precedes the form of inflammation of the peridental membrane which affects the apical space, yet there are other forms of periodontitis which exist independent of the dental pulp; for example,—an acute, non-purulent form which occurs around the necks of the teeth; an acute, non-purulent, circumscribed form which affects one side of the root-membrane, or may encircle the root about its middle portion. There are also other forms of this affection, such as an acute non-purulent form which may originate in and be confined to the apical space; an acute non-purulent form which may arise in the apical space and extend over the greater part of the peridental membrane below the marginal portion; an acute purulent form which involves the apical space only; an acute purulent form which may arise in the apical space as a result of the apical form, and extend over a considerable portion of the peridental membrane. Chronic forms of periodontitis also exist, which differ from the acute forms in the character of their phenomena, which are not so intense as those of the latter. The peridental membrane is confined between the walls of the alveolar cavity and the root of the tooth, and as a consequence is incapable of expansion when its vessels are engorged with blood, and being endowed with a large supply of nerves, which render the membrane very sensitive even in a normal condition, it becomes excruciatingly painful when inflamed.

Inflammation of the peridental membrane of a tooth may therefore be *acute* or *chronic*, the acute forms being generally due to direct local irritation and the chronic forms to the result of the acute forms, or to systemic influences. Each variety is modified in its character by the state of the constitutional health and by the causes concerned in its production, and also its location, extent, etc. The premonitory symptoms of the acute varieties, especially when they are apical or diffuse, are a slight sensation of uneasiness and tension, a feeling of

fullness about the affected part, and a desire to press the teeth together. Pressure appears to afford temporary relief, but the uneasy feeling returns on the pressure being withdrawn.

These symptoms are soon followed by a dull, heavy, and continuous pain, and the affected tooth appears to be longer than the adjoining ones, and is really so, owing to the increased thickness of the investing membrane of the root. Occlusion of the teeth gives rise to severe pain, and there is an inclination to keep the jaws apart. The appearance of the gums at this stage of the affection also indicates the existence of disease in the peridental membrane; they become very tender and swollen, and change from a pale rose color to a deep red or purple opposite the root of the affected tooth.

At first the inflammation is circumscribed, but soon it becomes more general, until the whole of the gum about the root of the tooth is involved. Although the pain increases in severity, it yet preserves the same character, and even when not continuous, it seldom ceases for any great length of time. At length suppuration occurs, and we have the condition known as alveolar abscess, this process sometimes extending to nearly every part of the periosteum, causing the entire death of the tooth, and often followed by erosion of the root and necrosis of the alveolus. When favored by a cachectic habit of body, it often extends to the periosteum of the jaw, followed by suppuration and necrosis.

The inflammation of the peridental membrane has been classified according to its location, symptoms, causes, and results, such as *acute cervical periodontitis*; *acute circumscribed periodontitis*; *acute apical periodontitis*, and *acute diffuse periodontitis*. When the inflammation of this membrane terminates in suppuration, such forms, according to their location, causes, symptoms, and results, may properly be classified as forms of alveolar pyorrhea and alveolar abscess.

Acute cervical periodontitis is characterized by an area of bright red gum, corresponding in extent to the area of inflamed peridental membrane about the neck of the tooth. The gum is detached from the neck of the affected tooth to a greater or less degree; and when salivary calculus is present, the margin of the gum assumes a bluish color. The pain resulting from this cervical form is seldom acute, but more frequently consists of an annoying sensation; the tooth is sensitive to pressure, and sometimes to thermal changes, unless the cause is due to salivary calculus, when a soreness instead of a decided pain is experienced about the neck of the affected tooth.

Acute circumscribed periodontitis is usually confined to that portion of the peridental membrane which is midway, or thereabouts, between the cervical and apical portions. This form of the disease may en-

circle the root of the tooth or be confined to the lingual surface of the root. Pressure from the opposite side causes pain, and percussion elicits a dull sound. When due to a local irritant or injury, this form may continue for from one to three days; whereas if it is caused by constitutional derangement, it is liable to assume a chronic character and be more persistent.

Acute apical periodontitis is first characterized by soreness of the tooth, and light redness of the overlying gum. The affected tooth at length becomes loose, and is elevated in its cavity above the level of the adjoining teeth, owing to the thickening of the peridental membrane by the effusion of watery liquid from the blood into the affected tissue. The pain resulting from this apical form is acute and pulsating, and often extends to the entire side of the face, becoming more severe toward evening, especially when the sufferer assumes a recumbent position; active exertion and the use of alcoholic stimulants aggravate the pain. The tooth is also very sensitive to cold, and the gum over the root is quite hot. Mastication is exceedingly painful, and in some cases closure of the jaws is difficult. Percussion elicits a very dull sound in the affected tooth. This acute apical form comes on gradually during one or two days or more before it is fully developed, and may then continue for four or five days, or even longer, when it may assume a chronic character which is indicated by an abatement of the symptoms.

Acute diffuse periodontitis is usually a result of the extension of the inflammation of the peridental membrane from the apical space over the greater portion of the membrane, although it may not involve the cervical portion. While the symptoms of the diffuse form resemble those of the apical form, they manifest themselves with greater severity. The tooth affected with the diffuse form of periodontitis becomes very loose in its cavity, is greatly elevated above the adjoining teeth, and elicits an exceedingly dull sound on percussion; it is also very sensitive to pressure from any direction, and mastication and closure of the jaws are impossible. The gum over the root of the affected tooth is very much swollen and of a dark red color. The pain experienced is of a very severe, throbbing character, and these severe symptoms may continue for three or four days or even a week, when they abate, or the inflammation assumes a chronic form.

Acute inflammation of the peridental membrane having terminated in suppuration, sometimes, instead of subsiding altogether, degenerates into a chronic form, and when favored by some constitutional vice, as the scorbutic, venereal, or scrofulous, it often gives rise to the destruction of the socket and loss of the tooth.

The acute form of periodontitis is readily diagnosed by the pain

caused by pressure on the affected tooth, which distinguishes it from such diseases of the dental pulp as irritation and inflammation or pulpitis. Besides, the pain of periodontitis can always be definitely located, whereas in pulpitis its exact location is often doubtful ; again, the dental pulp is influenced by thermal changes to such a degree as to very greatly increase its sensibility when diseased, whereas the peridental membrane is not so influenced, and its sensitiveness is not increased to any marked degree by thermal changes, except when the pulp cavity contains gas, which expands from heat and induces pressure on the tissues beyond the apical foramen.

Chronic inflammation of the peridental membrane is generally preceded by the active form of the disease, but it may assume the chronic form at the commencement. In this case it is complicated with tumefaction of the gums and discharge of puriform matter from between their edges and the necks of the teeth. Chronic periodontitis is therefore but a modified form of the acute, and is manifested by soreness of a tooth, which may either be so slight as to occasion very little annoyance, or be very considerable, with apparent congestion of the gum about the tooth, and sensitiveness of a greater or less degree when the organ is pressed upon.

After the loss of vitality in the pulp of a tooth, the peridental membrane is very susceptible to inflammation, owing to the irritation to which it is subjected, and also to the weakened condition of this membrane and its increased function in supplying the cementum and dentine with nourishment.

Causes.—*Acute cervical periodontitis* is caused by chemical and mechanical irritants, such as decomposing food and other matters retained about the neck of a tooth, and in connection with the peridental membrane ; also the bristles of tooth-brushes, small particles of bone, and other foreign substances forced under the gum in mastication, etc. ; also improperly fitting bands, metal crown-caps, overlapping fillings, and salivary calculus.

Acute circumscribed periodontitis is the result of mechanical injury or of constitutional derangements, the latter cause being first noticed in a former edition of this work.

Acute apical periodontitis is of frequent occurrence, and is generally the result of pulpitis caused by chemical and mechanical irritants. A putrescent or gangrenous condition of the pulp of a tooth is a common cause of this form of the disease ; also filling materials and irritating agents used for disinfecting and antiseptic purposes, forced through the apical foramen into the apical space ; broken nerve instruments ; metallic fillings built too high upon the grinding surfaces of a tooth ; too rapid wedging and too rapid regulating of teeth ; severe malleting ;

improperly filled cap-crowns and bridge-work, and badly antagonized artificial teeth exercising undue pressure on a natural tooth.

Acute diffuse periodontitis is caused by inflammation of the pulp, chemical and mechanical irritation of the membrane lining the apical space, and constitutional derangements. Acute pulpitis and a putrescent condition of the pulp are frequent causes. Inflammation of the pulp from any cause may involve the peridental membrane of the apical space and thus establish periodontitis.

Constitutional derangements may consist of a syphilitic taint through an infiltration of lymph and serum into the peridental membrane, or between it and the root of the tooth or alveolar walls of the socket; also rheumatism, especially in those who have been subjected to an excess of mercury, and also scrofula. This affection may also extend from the peridental membrane of one tooth to that of adjoining teeth.

Treatment.—The treatment of the different forms of periodontitis will depend upon the location, the causes producing and influencing the disease, and the condition of the general system.

The treatment of the *acute cervical* form consists in the removal of the irritant, the disinfection of the mouth, and the use of an astringent or antiphlogistic lotion.

The mouth may be disinfected by pyrozone (30 per cent. solution) in the form of a mouth wash, or by iodoform, iodol, eucalyptus, iodin, euclophen, salicylic acid, glycozone, listerine, resorcin, and a number of other disinfectants and antiseptics all in proper solution.

The treatment of the *acute circumscribed form*, when originating from mechanical violence, consists in the application of antiphlogistic lotions, of which the following is an example:—

R.	Plumbi acetat,	. . . . .	3j.
	Tinct. opii,	. . . . .	3ss.
	Aquæ,	. . . . .	3vij to x.

SIGNA.—Apply as a lotion on lint or cotton to the gum surface about the affected roots.

When this form of periodontitis is due to other causes, the local application of equal parts of tinct. of iodin and tinct. of aconite will prove serviceable. When depending upon constitutional derangements, constitutional treatment for the particular disease present is indicated.

The treatment of the *acute apical form* of periodontitis when this form of the disease is due to external violence or irritation, consists in the removal of the irritant and the application of antiphlogistic or counter-irritant applications. The antiphlogistic combination of

acetate of lead, tincture of opium, and water, or the counter-irritant combination of aconite and iodin often prove serviceable.

When due to pulpitis or to foreign substances forced through the apical foramen or the side of the root of the tooth, the prognosis is more unfavorable, and the destruction of the vitality of the pulp and its complete removal, or the removal of foreign matters from the pulp canal and the use of disinfectants, is necessary.

The treatment of the *acute diffuse form* of periodontitis is similar to that of the acute apical form, and the prognosis is yet more unfavorable for the preservation of the vitality of the pulp. This form is very prone to degenerate into a purulent inflammation, when it may be classed as alveolar abscess, the treatment of which demands the opening of the apical foramen by means of a fine broach, and entrance into the abscess to evacuate the pus, followed by the proper disinfectant and antiphlogistic treatment and the filling of the pulp-canal and crown-cavity of the tooth.

The first thing to be attended to in cases where the prognosis is unfavorable to the preservation of the pulp is its devitalization and the removal of all irritants from the pulp-cavity, such as an inflamed or decomposing pulp, after which the congestion of the affected part may be relieved by the use of such agents as produce counter-irritation, or by depletion.

When the pulp of the tooth is inflamed it should receive immediate attention, and when the pulp is dead, all the debris should be removed from its pulp-cavity by means of nerve instruments and syringing with tepid water. All deposits of calculus should be removed from the teeth, and also all dead teeth and roots which are useless and cause irritation, should be removed from the mouth. The pulp-cavity should then be thoroughly disinfected by iodoform, or eucalyptus, iodin, carbolic acid, salicylic acid, sanitas, etc. After the application of the disinfecting agent, the pulp-cavity should be loosely filled with cotton saturated with an antiseptic agent, but sufficiently close to prevent the entrance of fluids. If a secretion of pus is present the application may be frequently changed, and thus prevent the pressure of the secretion from causing pain. In severe cases where the above treatment does not prove effectual, counter irritation may be resorted to; the gums may be scarified, or such agents be applied as iodin and creasote, tincture of capsicum, and tincture of iodin. An excellent application is composed of equal parts of the official tincture of iodin and tincture of aconite root applied to the gum two or three times daily, in the acute form of the affection. Previous to the application, the gum should be dried, and afterward the cheek kept from coming in contact with it

until a metallic pellicle is formed. Cantharidal collodion is also an excellent counter-irritant, and is applied to the gum, after the surface is dried with a napkin, by means of a camel's-hair brush, taking care to protect the lip, and to prevent moisture from interfering before the ether in the preparation evaporates and an artificial cuticle is formed. Within a few hours blistering results, and the periodontitis is effectually relieved. Another method of producing counter-irritation is to make a deep incision in the gum over the affected root, and to introduce into this a small pellet of cotton or lint saturated with creasote or carbolic acid, which is retained for from one to five days, the time depending upon the persistence of the inflammation, taking the precaution to change the dressing every day. The application of a solution composed of equal parts of tincture of aconite, tincture of opium, and chloroform, is often very serviceable; also a small linen bag containing capsicum, one side of the bag being covered with leather, to protect the cheek. Lead-water, in the proportion of a fluidounce to two fluidrams of laudanum, applied in the same manner as the agent before named, has also been successfully used. Depletion may be accomplished by means of the gum lancet, or by the use of leeches or cups.

Hypodermic injections of morphine have also been resorted to for the relief of the intense pain of this affection, such as a solution of morphine or tincture of opium, some ten to twenty drops of the latter being injected with a suitable syringe beneath the mucous membrane; also, with good effect, the application of rhigolene or ether spray until the gum about the affected tooth is blanched. As a topical application, rhigolene has been recommended, applied to the gum on a pellet of cotton after free scarification.

Constitutional treatment is also serviceable, such as the administration of saline cathartics. Bromid of potassium in a dose of twenty-five grains, or the same quantity of the bromid combined with five drops of the tincture of veratrum viride, and repeated every four hours, will often prove serviceable in incipient alveolar periodontitis. A preparation known as *mercurius vivus*, the third decimal trituration, given in small doses two or three times a day, has been recommended by Prof. Chase and used successfully by others in relieving acute periodontitis. During the treatment, a cap of gutta-percha, molded to the crowns of one or two teeth on the opposite side of the jaw, will protect the affected tooth from any irritation which may be caused by the occlusion of the opposing ones, and thus facilitate the restoration. For the treatment of the chronic variety of periodontitis, the reader is referred to "Chronic Inflammation and Tumefaction of the Gums."

ALVEOLAR ABSCESS.

An alveolar abscess is a collection of pus in a sac attached to and closely embracing the root of a tooth, and is the result of inflammation of the tissues of the apical space, where its inception invariably occurs. The peridental membrane having become the seat of acute inflammation, plastic lymph is effused at the extremity of the root. This is condensed into a sac or cyst, which closely embraces the root near its apex, the walls of lymph become vascular, and perform the functions of secretion and absorption, and as suppuration takes place, pus is formed in the centre of the sac. The inflammation in the meantime having extended to the gums and neighboring parts, they swell and become painful, and as the pus accumulates in the sac, it distends and presses upon the surrounding walls of the alveolus, which, by a chemico-vital process, are gradually broken down. By absorption, through pressure, an opening is ultimately made through one side of the alveolar cavity, when the pus, coming in contact with the investing soft structures, presses upon them and causes their absorption also, or it may follow the side of the root to the margin of the gum, and thus outlets are effected for the escape of the accumulated matter.

In some cases the pus may separate the periosteum from the bone of the alveolar cavity and form a receptacle for itself between the membrane and alveolar wall, and if not promptly discharged may cause necrosis of the bone.

The pus of an alveolar abscess, in the case of young persons, usually finds an exit through the root canal of the tooth, especially when the abscess is formed upon the apex of the root, owing to the large size of the foramen of a deciduous tooth. In adult persons the escape of the pus generally takes place through the alveolar wall and the soft tissues opposite the root of the affected tooth.

The secretion of an alveolar abscess, especially when an inferior molar is affected, may find its way to the surface of the cheek or neck, and considerable deformity be caused from the cicatrix resulting. In some cases the sinus of an abscess may invade the duct of a salivary gland and necessitate the operation for salivary fistula before a cure can be effected; but the secretion may escape from a more remote point. It may make for itself an opening through the cheek or through the base of the lower jaw, and be discharged externally; or it may pass up into the maxillary sinus, or through the nasal plate of the superior maxilla, or form a passage between the two plates of the bone, and escape from the centre of the roof of the mouth.

The formation of abscess in the alveolus of an inferior dens sapientiae is sometimes attended with inflammation and swelling of the ton-

sils and of the muscles of the cheek and neck. The author has known trismus to result from this cause.

The pain attending the formation of alveolar abscess is deep-seated, throbbing, and often so excruciating as to be almost insupportable. But as soon as suppuration takes place, it loses its severity, and with the escape of the pus nearly or altogether ceases; but the tooth, from the thickened condition of the peridental membrane particularly at the apex of the root, often remains sore and sensitive to the touch for several days. The energies of the disease, however, having been expended, the secretion of the pus in the majority of cases wholly ceases, and the opening in the gums closes. From the increased susceptibility of the peridental membrane to morbid impressions, occasioned by the presence of a tooth deprived of a large portion of its vitality, a recurrence of the inflammation is liable to take place, when pus will be again formed and the passage for its escape re-established. But the pain attending any subsequent attack is seldom so severe as in the first instance.

There are some cases, however, in which the inflammation, instead of subsiding altogether, degenerates into a chronic form of abscess. In this case, the sac at the extremity of the root continues to secrete pus, though the quantity is usually small, and the opening in the gums remains unclosed.

Persons of a scrofulous diathesis are very liable to this affection, which, in these cases, very soon assumes a chronic form.

In the extraction of a tooth which has given rise to the formation of abscess, the sac is often brought away with it. Two teeth in which



FIG. 120.

this had happened, taken from the upper jaw—one a cuspid and the other a first molar—are represented in the accompanying cut (Fig. 120). In the case of the molar the sac is attached to the palatine root. Both of these teeth were extracted previously to the formation of an external opening for the escape of the matter.

Although in the majority of cases the sac is attached to the apex of the root, yet it is not unusual for the point of attachment to be on the side of the root, as in the case of the superior front teeth and bicus-pids, or in the bifurcation of the roots, in the case of the molars, for example. When the sac is situated upon the side of the root of a superior front tooth, it is generally upon the labial surface, and when it is situated at the apex of the root of a molar tooth the palatine root is the one generally affected. The temporary teeth are much more liable to this disease than the permanent teeth, and the

superior incisors more susceptible than the inferior teeth of the same class.

But the treatment of inferior teeth affected with abscess, especially the bicusps and molars, is often more difficult than that of the superior, on account of the gravitation of the pus and the impossibility in many cases of making an opening through the alveolar process so low as the extremity of the root, owing to the muscular attachment being so high on the ridge.

The character of the secretion differs considerably in different cases; instead of the yellowish-white appearance that pure or laudable pus presents, and which may be present in some cases of alveolar abscess in good constitutions, a highly vitiated, acrid fluid, with either a diminished supply of pus corpuscles or an entire absence of such corpuscles, usually distinguishes the secretion, which sometimes becomes very irritating in its effect upon living tissue. The systemic condition of the patient modifies the character of the secretion, as also does the nature of the local irritants.

The time required for the formation of alveolar abscess varies from three to ten or fifteen days, according to the violence of the inflammation. But a collection of pus may be detected by fluctuation under the finger, if applied to the tumefied gum one or two days before an external opening is spontaneously formed for its escape.

The size of the cavity formed by an alveolar abscess depends upon the severity of the disease and the susceptibility of the parts involved. In some cases it is quite small and confined to the point of irritation, while in others it may be very extensive. Very severe pain accompanies this affection when the abscess is rapidly formed, owing to the distention occasioned and the inability of the secreting pus to escape. As soon as an opening is effected, however, the tension is relieved and the pain subsides. A great susceptibility to alveolar abscess exists in case of an inflammatory diathesis, and after a time it may assume a chronic character, when the secretion and discharge of the pus is continuous. Although the pain of chronic abscess may not be more than a slight uneasiness, the acute form is productive of intense pain. There is also a difference in the extent of the inflammation affecting neighboring tissues, depending upon the activity of the irritants present, and in some cases of alveolar abscess the inflammation of adjacent parts may be very limited, while in others it may be very extensive.

The inflammation and pain attending the formation of abscess in the alveolar cavity of a tooth often give rise to general febrile symptoms, headache, and constipation of the bowels. In the acute form of this disease the pain is intense, while in the chronic form, where the

pus is constantly secreting and discharging, the sensation experienced is soreness and an uneasy feeling, with a slight pain upon a change of temperature.

Chronic alveolar abscess generally follows the acute form, and results from a subsidence of the acute symptoms into others less painful, but more persistent. The chronic form is generally accompanied with a fistulous opening which, in its position and the direction of the canal, presents quite a variety of forms. The fistulous opening is usually, however, upon the gum over the root of the affected tooth; but in some cases the fistulous opening may close and the secretion from the abscess appear at a different point some distance from the original one. In other cases a chronic abscess may again assume acute symptoms, which may continue until a new exit for the secretion manifests itself at a more remote point. These chronic cases often cause a feeling of stiffness, caused by the pus burrowing through muscular tissue, as the secretion will generally follow a course which presents the least resistance. The direction of the pus is also influenced by gravitation, especially in abscesses connected with the inferior teeth. Abscesses connected with the inferior molar teeth sometimes discharge into the antrum and produce serious complications. Abscesses discharging on the face are generally connected with the inferior molar teeth and are influenced in this respect by gravitation, and the least resistance the pus in its burrowing course may meet with. The closure of a fistulous opening of a chronic alveolar abscess may lead to the retention of the pus, which, on account of gravitation, in the case of an inferior tooth, penetrates to the surface along the border of the lower jaw. Abscesses connected with the superior teeth, when pointing on the face, generally discharge beneath the prominence of the malar bone, and the deformity resulting after the healing of the fistula is caused by the formation of a dense cord of new tissue which binds the skin permanently to the bone, and which must be severed in the treatment for correcting such a deformity.

Causes.—The immediate cause of alveolar abscess is inflammation of the peridental membrane, which is frequently incited by inflammation of the pulp and its subsequent death and decomposition, irritating matter being thus formed, which sooner or later affects the tissues of the apical space through the apical foramen of the tooth. Such a condition is often the result of filling the cavity in the crown of a tooth, and permitting a dead and decomposing pulp to remain in the pulp-cavity. It may also be produced by mechanical violence, the irritation of a dead tooth, or by a drill accidentally passing from the canal through the side of the root into the peridental membrane, or by the

presence of a portion of a filling, a broken broach, or other foreign matter, or irritating medicinal agent, forced through the root of a tooth.

Treatment.—The treatment of alveolar abscess should be preventive rather than curative, for it often happens, after it has occurred, that the integrity of the parts is so impaired as to cause a recurrence of the affection. Although the secretion of pus may cease for a time, and the opening in the gums become obliterated, the tooth, being deprived of a large portion of its vitality, is liable, whenever the excitability of the peridental membrane is increased by any derangement of the general system, to give rise to a recurrence of the disease. Especially is this the case when the disease has assumed the chronic form. The formation of an abscess, therefore, should, if possible, be prevented by the use of such means as are referred to in the treatment of "periodontitis," a common termination of this disease being alveolar abscess. But should these means fail to prevent the formation of pus, we then have to resort to either therapeutic or surgical treatment, consisting in the removal of the irritant matter from the pulp-cavity.

An alveolar abscess of recent origin will yield more readily to treatment than one of long continuance, and the chronic form is much more difficult to arrest, especially after the adjacent parts have become involved, than the acute form.

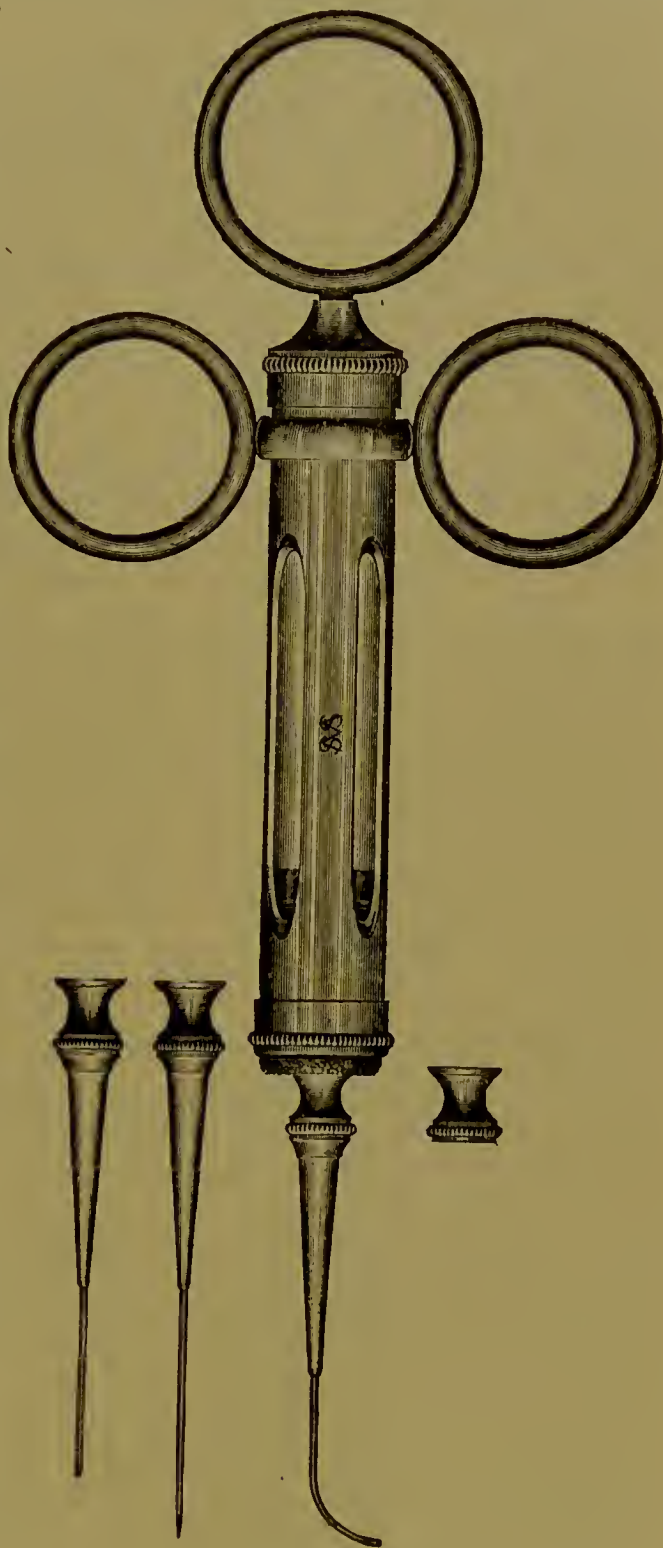


FIG. 121.

When constitutional derangement is present, general treatment, such as the particular condition indicates, must be resorted to. The local or surgical treatment consists in breaking up the sac of the abscess, and the evacuation of the pus as soon as possible, and ready access must be had to the point of accumulation in order to successfully accomplish such a result.

A sharp-pointed bistoury or small trephine may be employed to enlarge the fistulous canal when the pus has made an opening through the process and gum to the surface opposite the root of the tooth, and the sac broken up by means of nerve instruments, its remains being thrown off and healthy granulations developing without further treatment. In many cases, however, therapeutic treatment must follow the surgical before a perfect cure is accomplished. The therapeutic treatment consists in first removing all irritating substances from the pulp-cavity, which should be freely opened to the apex of the root, and the application of disinfectant and antiseptic remedies. For cleansing the root, peroxid of hydrogen, chlorid of sodium, etc., injected into the canal answers a good purpose, to be followed by such agents as will cause the absorption or destruction of the sac secreting the pus, such as creasote, carbolic acid, mercuric chlorid, followed by alcohol, peroxid of sodium, salicylic acid (applied in the solid form), nitrate of silver, iodin, etc. When a tumor appears on the gum from the presence of the pus which has penetrated the bone, the contents of the abscess should first be discharged by making an opening in the tumefied gum with a sharp lancet, provided the disease has been allowed to progress to such a degree as to render this operation necessary. The opening in the gum should not be allowed to close until the pulp cavity has been exposed and the decomposed contents removed, when this cavity should be thoroughly disinfected by such agents as mercuric chlorid, followed by alcohol, peroxid of sodium, iodoform, iodol, aristol, sulphuric acid, etc., etc. If no opening has been formed through the alveolar process the decay in the crown cavity should be removed, and the orifice of the pulp canal be so enlarged as to admit a nerve instrument or small broach, by means of which it can be cleaned out, and thus allow the matter to escape through the tooth. Tepid water should then be injected into the pulp canal by means of a small syringe, until all decomposed matter is removed, when one of the remedial agents mentioned above may be substituted for the tepid water, or applied on a strand of floss silk, which is carried to the apex of the root by means of a nerve instrument or broach. At the end of twenty-four or forty-eight hours, according to the character of the symptoms, this treatment is repeated, the crown cavity during the interval being filled with cotton. A

combination of several of the remedial agents is serviceable in obstinate cases, such as creasote and tincture of iodine, carbolic acid and tincture of iodine, or creasote and tannin in alcohol, aristol and chloroform, iodoform and eucalyptol, etc., etc., which can be applied on floss silk, introduced daily for two or three days, until the discharge ceases.

Fig. 121 represents an abscess syringe, of improved form, with two gold points—straight and curved—and one hypodermic point. The metal case is slotted to expose the glass barrel, and provided with finger-holds.

The application of the vapor of crystals of non-agglutinated iodoform, as recommended by Dr. Peabody, so that it may be forced into the canal, thoroughly permeating it and filling the tubuli, a precipitate being thus deposited which forms a solid, insoluble filling, is also very effective. The cylinder of a hot-air syringe is partly filled with the crystals and heated over a flame until they are fused. This vapor also penetrates the apical foramen and subdues the irritation and inflammation of the peridental membrane.

The following solution of Dr. Percy Boulton possesses therapeutic virtues of superior efficiency, especially after creasote, carbolic acid, eucalyptus, iodoform, iodine or salicylic acid have been employed to stimulate and disinfect the secreting surfaces to a healthy action :—

R.	Tr. iodine comp.,	℥xiv.	
	Acid. carbolic. cryst. (fusa),	℥vj.	
	Glycerinæ,	ʒ viij.	
	Aq. destillat.,	ʒ v.	M.

This solution possesses antiseptic and stimulant properties.

The surgical treatment consists in making an opening, or enlarging the fistulous one, through the alveolus, opposite the extremity of the affected root, by means of a small trephine, drill, or chisel, first making a vertical incision in the gum with the lancet, and thus gaining access to the seat of the disease. The attachment of the sac to the root is then broken up by means of a delicate instrument which permits of being passed about the extremity of the root, and the wound in the gum kept open for a few days by inserting a tent, in order that the remains of the sac may escape, and such agents as tannin and glycerin, carbolic acid and glycerin, etc., or the Boulton formula, may be applied. It rarely happens that this surgical treatment can be made through the pulp canal of the root and without an opening in the alveolar process. During treatment, to prevent the occlusion of the teeth, where this may be necessary, a cap of gutta percha can be molded over the adjoining teeth by first softening this material in warm water.

The excision of the apices of the roots of teeth, by means of a small trephine, and thus bringing away the sacs also, has been recommended as successful surgical treatment of alveolar abscess.

Dilute aromatic sulphuric acid is a very reliable application, either alone or combined with a small quantity of tincture of capsicum, in chronic cases of alveolar abscess of long standing associated with a necrosed condition of the margins of the processes. The use of sulphuric acid is also recommended for opening root-canals to gain access to the pus-sac.

Replantation is also resorted to, and in many cases may prove efficient, if care is exercised to remove all coagulated lymph and diseased membrane, and also to fill the canal permanently before returning the tooth to its cavity. Under favorable circumstances a tooth thus treated may become firmly attached within a few days.

When escharotic agents are injected into the pulp-cavity and through the fistulous opening in the process and gum, their contact with the mucous membrane may be prevented by applying the rubber dam, or by the introduction of a Hill's stopping filling in the crown cavity, in the center of which an opening is made to admit closely the point of the syringe, while at the same time the parts about the fistulous opening are protected by bibulous paper, cotton, and napkins. When there is a tendency of the accumulated pus in the sac of an abscess upon one of the inferior teeth to discharge through an external opening in the cheek, or beneath the jaw, this result may be prevented by a free incision in the gum opposite the root of the affected tooth; should the discharge, however, through an external opening be inevitable, the immediate extraction of the tooth is necessary.

The application of fomentations and emollient poultices externally are rarely productive of any advantage, and may do harm by promoting the discharge of matter through the cheek or lower part of the face. When this occurs a depression, with puckering of the skin, is apt to remain after the escape of pus through the opening ceases and the orifice has closed, causing disfiguration of the face, which is caused by the formation of a strong cord of new tissue which binds the skin firmly to the bone.

It rarely happens, however, that anything more is necessary for the cure of the external opening than the extraction of the tooth which has given rise to the formation of the abscess.

The formation of an abscess in the alveolus of a lower wisdom tooth is sometimes productive of very serious and even alarming consequences, such as obstructed deglutition, fever, difficult respiration, rigidity of muscles of jaw, and inability to open the mouth.

The late Prof. Thomas E. Bond recorded the case of a superior cen-

tral incisor affected with a chronic alveolar abscess where the discharge of pus occurred from behind the curtain of the palate, and which ceased on the removal of the affected tooth after continuing for over twelve months; and another case was recorded by Prof. Chapin A. Harris, where the discharge of pus from an abscessed superior first molar passed up into the posterior nares, and found exit behind the velum palati.

Inflammation of the investing membrane of the roots of an inferior dens sapientiæ may produce equally serious effects, without occasioning the formation of an abscess in the alveolus. The eruption of these teeth is sometimes attended with like consequences. The irritation has, in some instances, extended to the lungs, and even been, in such diatheses, the exciting cause of consumption.

The occurrence of alveolar abscess in the cavity of a temporary tooth is often followed by exfoliation of the sockets of several teeth, and sometimes of considerable portions of the jaw-bone, seriously injuring the rudiments of permanent teeth and sometimes causing their destruction. The author saw a case, a few years since, in which an abscess of the alveolus of the first lower temporary molar had occasioned exfoliation of the sockets of a cuspid and two molars. About one-half of the alveolar cells of the two bicuspid and the cuspid of the second set were also exfoliated, thus leaving their imperfectly formed crowns entirely exposed.

The treatment of the chronic form of alveolar abscess is generally confined to the removal of the cause of the affection, or at least to that of the secretion, which in simple cases consists in the cleansing of the pulp-cavity of all irritating matter, which by its decomposed condition promotes the formation of pus. The application of disinfecting agents is then indicated, such as peroxid of hydrogen, mercuric chlorid followed by alcohol, peroxid of sodium, eucalyptus, iodoform, iodine carbolic acid, salicylic acid, etc.

Peroxid of hydrogen or sulphuric ether answer as good cleansing fluids in the form of injections by means of an abscess syringe. The entire tract of the abscess and fistulous opening should be subjected to the action of the disinfectant. Dr. G. V. Black has successfully employed a combination of carbolic acid two parts, oil of cinnamon one part, and oil of gaultheria three parts, in the form of an injection as a stimulant disinfectant. The presence of sanguinary calculus on the root of a tooth affected with the chronic form of alveolar abscess may retard or prevent the successful treatment until such an irritant is removed.

ALVEOLAR PYORRHEA.

Alveolar Pyorrhea, commonly designated "Riggs' disease," denotes suppurative inflammation of the gums and peridental membranes, attended with the destruction of the alveolar processes. It usually commences with an uneasy sensation in the gums and teeth, which soon become painful.

At an early stage of this disease the margin of the gum presents decided inflammatory action and bleeds from slight causes.

As the disease progresses, the inflammation extends deeper into the substance of the gum, which becomes greatly congested with venous blood, swollen, and exhibits a tendency to separate from the necks of the teeth, which gives rise to the formation of small sulci filled with pus. There is also a loss of substance of the gum, and the destruction of the margins of the alveolar processes is followed by the death of the thicker portions beneath, and, as a consequence, the teeth become loose and change their positions. There is frequently a separation and protrusion of the superior and inferior front teeth, with a thick, fetid discharge from about their necks, which causes a disagreeable taste and a very offensive breath. The gum at this stage of the disease is of a dark purple or livid hue, with a congested margin, and in some cases, on account of its being denuded of its epithelium, its surface presents a polished appearance; it may also become granular and covered with fungous excrescences. At an extreme stage of the disease, complete destruction of the alveoli and of a considerable portion of the gum occurs, and the teeth are held in place by a tough, ligamentous attachment, which was formerly the peridental membrane. The roots of the teeth become coated with a layer of calculus, often of a greenish-brown color and great hardness, which adheres tenaciously, rendering its removal very difficult.

Although the two forms of calculus, the salivary, which is derived from the saliva, and the sanguinary, from the serum that exudes from the gums when diseased, cause inflammation of the peridental membrane, yet the latter form of calculus appears to be more commonly associated with this suppurative inflammation than the former.

The congestion and consequent recession of the gum from about the necks of the teeth permits the salivary form of calculus to be deposited on the roots, by the ready access afforded to the fluids of the mouth; while the pathological condition of the tissues in connection with the teeth causes a serous exudation, the result of which is the deposit of the harder variety of calculus.

The nature of this calcic deposit is no doubt modified by the serous fluid from the gum.

Causes.—Although one form of alveolar pyorrhea is a disease which may depend almost wholly upon local causes, such as the irritation of salivary and sanguinary calculus, and especially this latter form of calcic deposit, and a perverted condition of the secretions, yet the peculiar manifestations of another form often depend upon some unfavorable diathesis, which enables the local causes to produce more serious effects than might be possible in better systemic conditions. If the teeth are perfectly free from irritating accretions, and present smooth, polished surfaces at points where the more highly vitalized surrounding structures come in contact with them, no inflammatory action will occur in such structures. On the other hand, if the teeth, on account of calcic deposits about the margin of the gum and along their roots, act as irritants, inflammatory action, followed by such effects as one form of the disease under consideration presents, may ensue. And again, if a gouty diathesis is present due to a superabundance of uric acid in the system, the aggravated symptoms of another form of this affection manifest themselves. Low vitality and all diseases which affect the circulation may be named as predisposing causes of alveolar pyorrhea.

Dr. Black, in describing this disease under the title of “phagedenic pericementitis,” maintains that it is of local origin, while Dr. Atkinson ascribes it to constitutional causes. There is good reason, however, for believing that there are both predisposing and exciting causes for this disease. Prof. C. N. Peirce believes that it is principally due to a gouty diathesis of the system, and he defines two forms of this affection: in one the origin of the calcic salt is the saliva, and in the other the blood. The former he designates as *ptyalogenic calcic*, its origin being local and salivary; the latter *hematogenic calcic*, its origin being constitutional, and associated with some modifications of the normal composites of the blood plasma. The calcic pericementitis may have its origin at the gingival border, the salivary calculus acting as a local and mechanical irritant with such concomitants as irritation, inflammation, suppuration, absorption of gum and alveolar process. He says: “We have three distinct abnormal conditions affecting the gums, peridental membrane, and alveolar processes. The first is gum inflammation and destruction, caused by a mechanical irritant; second, inflammation of the gingival borders without the presence of salivary calculus. The third is pericemental irritation commencing at or near the apical extremity of the root, due to the presence of some morbid composite of the blood exuded with the plasma and infiltrating the peridental membrane, and frequently deposited or precipitated upon the root of the tooth near its apex. This latter I designated true pyorrhea alveolaris, or hematogenic pericementitis, and so in-

timately is it associated with some other local manifestation of a gouty diathesis, that I believe it to be another local expression of that systemic condition." That a superabundance of uric acid in the system may assist in producing alveolar pyorrhea is the general opinion, but from the fact that uric acid may be present in the system without producing either gout or rheumatism, Drs. Bödecker, Darby, James, Truman, Rhein, and others dissent from the views of Dr. Peirce and assert that uric acid will not exert more influence in producing alveolar pyorrhea than consumption, anemia, kidney and liver affections, syphilis, chronic nervous diseases, etc., which are often associated with alveolar pyorrhea; and they assert that the cause of this disease is a more or less chronic general ailment and not due to any particular form; also that many cases of alveolar pyorrhea can be attributed to nothing but heredity.

Treatment.—In the early stage of alveolar pyorrhea all calcic deposits should be carefully removed and the surfaces beneath well polished; a decided change for the better may occur in a very short time, as the inflamed gum will lose its congested appearance, and assume a lighter color and a firmer consistence, and become reduced to its normal thickness. In the more advanced stages of this disease the treatment consists in reaching, by means of narrow, sharp instruments, the extreme limits of the diseased action, removing all deposits, and breaking up the diseased tissue and necrosed bone, and polishing the surfaces roughened by depositions of calculus.

The diseased margin of the alveolar process must be removed to such an extent that the firm and resistant bone is reached by the edge of the cutting instrument, which a nice sense of touch will determine.

A nice sense of touch, only acquired by practice, will enable the operator to distinguish, with the instrument, foreign and dead substance from tooth structure and living bone. It is especially necessary that every particle of calculus and necrosed bone should be removed, as their presence will be indicated by a reddened patch of tissue, somewhat larger than the irritant beneath. As the removal of such irritants causes both pain and hemorrhage, such an operation will require several sittings and the frequent application of carbolic acid by means of a properly shaped piece of orange wood. After this operation is completed an application of dilute aromatic sulphuric acid will prove serviceable. The effect of such treatment is to promote the reproduction of new bone, and cause the gum to become firmly attached to it, and thus restore the stability of the teeth, and in many cases the only after therapeutic treatment necessary will be the use of an astringent wash, such as tincture of myrrh in its full strength, applied to the gum about the neck of the teeth. When constitutional disturb-

ance exists in connection with the local effects, after perfectly removing all irritants a dilute solution of chlorid of zinc may be applied to the ulcerating surfaces by passing it under the gum, about the necks and roots of the teeth, by means of cotton wound on a broach, and alternating with dilute aromatic sulphuric acid and tincture of iodine, applied to the surface of the gum. Chlorate of potash solution should be used as a mouth-wash after each meal and at night, with as thorough use of the brush as the condition of the gums will permit. The use of a solution of common salt is recommended during the intervals between the applications of the more powerful remedies; also phénol sodique.

For the worst stage of this disease, where the teeth are held in the mouth by means of the tough, ligamentous attachments only, their removal is inevitable.

The illustration (Fig. 122) represents Dr. J. M. Riggs's set of instru-

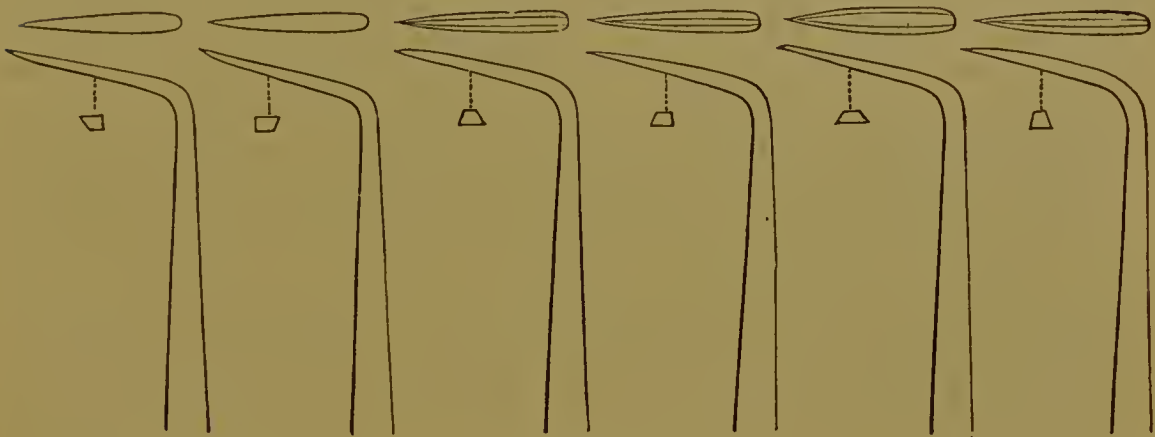


FIG. 122.

ments for the thorough removal of all salivary, sanguinary, and other deposits from the roots of the teeth, in the treatment of this disease.

Some prefer instruments with slender points, which require a pushing motion, instead of the curved hook or hoe-shaped instruments so commonly used for the removal of calcic deposits from the teeth, and which necessitate a motion toward the hand.

Whatever form of instrument is used, the thorough removal of all concretions from the teeth is absolutely necessary in this treatment, as all soft tissues are rendered unhealthy by the contact of calcic deposits. Dr. Cushing's set of scalers (Fig. 123) are well adapted for the removal of all calcic deposits from the teeth.

For the removal of slight deposits in the form of thin scales, Dr. Gilmer recommends that the gum be first expanded, so that it may stand off from the tooth, by packing under its free margin salicylized cotton, which is allowed to remain for twenty-four hours.

A method of treatment recently recommended by Dr. A. W. Harlan is as follows: For the acute form, the pockets formed by the separation of the gum should be first filled with iodoform and eucalyptus, iodoform and oil of cinnamon, or be thoroughly syringed with a one to three-grain solution to the ounce of water of chlorid of alumina, which is a good disinfectant and astringent. In three or four days the

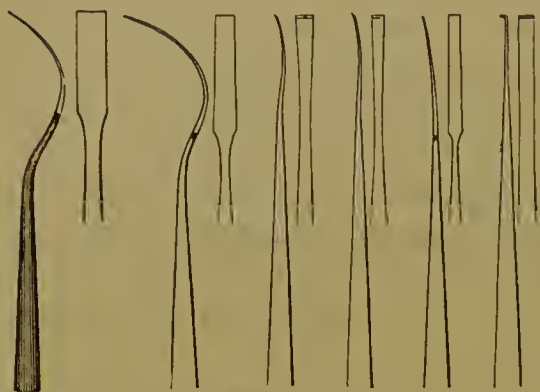


FIG. 123.

sanguinary deposits may be removed, as well as the edges of the alveoli. The pockets should then be syringed with peroxid of hydrogen, for the purpose of thoroughly cleansing them and also to destroy the micro-organisms present. After drying the gums the pockets should be injected with a solution of iodid of zinc, grs. xij to grs. xiv to the ounce of water, two or three

drops or more to each pocket. After several days have elapsed the gums should be carefully dried, and a fine cone of cotton or bibulous paper moistened with peroxid of hydrogen gently pressed into each pocket; if any pus is present effervescence will take place, when each pocket must be again injected with the iodid of zinc solution. In chronic cases, after the removal of the diseased bone and the careful cleansing of the roots, the pockets should be syringed with peroxid of hydrogen, followed by the injection of a xxiv gr. solution of the iodid of zinc, in the same manner as before described. In very bad cases a stronger solution of the iodid of zinc is recommended, xxvii grs. to the ounce of water; and when the margins of the gums present a ragged border or cone-shaped slit, pure granular iodid of zinc is applied to the edges of the slit once in three days, the injection into the pockets being repeated every fourth day. Combinations of iodoform and eucalyptus, iodoform and oil of cinnamon, iodoform and eugenol, chlorid of aluminum in the form of a solution composed of one to three grains to the ounce of water, sanitas, three parts to one part of eugenol, peroxid of sodium, have also been employed with benefit, in the form of paste and injections.

A strong solution of chlorid of zinc, 20 to 30 per cent., applied with care about the teeth by means of an abscess-syringe, will prove beneficial by relieving the congestion and constricting the soft tissues. The after-treatment consists in the use of stimulating applications, such as cinnamon-water, or carbolic acid combined with oil of cinnamon and oil of gaultheria, in the proportion of one dram

of the former and four to five drams each of the latter. Cleanliness should also be observed, and in the use of the tooth-brush the motion should always be lengthwise instead of across the teeth—a soft brush being preferable to a stiff one. It is advisable, in cases where the destruction of the alveolar process has not been great, to preserve the gingival margin, in order that a perfect restoration of the periodontal membrane may take place. Such an operation may be performed by introducing through the gingival aperture a bent chisel, or a hoe-shaped excavator, and the diseased structure removed as high up as it may extend toward the apex of the root. In cases where the cutting instrument cannot be introduced in such a manner without injury to the gingival margin, a flap of the soft tissue over the diseased bone may be raised, and all carious structure removed, as well as calcic deposits from the denuded root, through such an opening, without destroying the gingival margin. After the parts are thoroughly cleansed by injections of tepid water, stimulating applications may be made of carbolic acid (in crystals) one part, oil of cinnamon two parts, and oil of gaultheria three parts. Dr. Gilmer recommends for obstinate cases the use of carbolic acid and camphor, in the form of “phénol camphor,” which consists of equal parts of carbolic acid and gum camphor, prepared by melting such a mixture on a sand bath until an oily liquid is obtained; it is applied by means of a syringe to the pus-pockets. Before the application of disinfectants and antiseptics, the parts should be cleansed with the peroxid of hydrogen, either alone or combined with the bichlorid of mercury, pyrozone 5 per cent. solution, or solution of peroxid of sodium.

CHAPTER VI.

DISEASES OF THE DENTAL PULP.

THE pulp of a tooth, from the high degree of vitality with which it is endowed, is one of the most sensitive structures of the body, and, like other parts, is liable to become the seat of various morbid phenomena. Its susceptibility to morbid impressions is influenced by a variety of circumstances, such as temperament, habit of body, the state of the constitutional health, the condition of the hard structures of the tooth, etc. A cause, which under some circumstances would not be productive of the slightest disturbance, might under others give rise to acute inflammation, with all its painful and disagreeable

concomitants. Increased irritability (hyperesthesia) may exist independently of any organic change, either in the pulp, dentine, or enamel. Examples are often met with in females during gestation; but it arises more frequently as a consequence of caries than from any other cause connected with the teeth. Even before the disease has penetrated to the central chamber of the organ the pulp often assumes a most wonderful and marked increase of irritability, either from functional disturbance arising from decomposition of the dentine, impaired relationship between the two, or from being more exposed to the action of external deleterious agents. Impaired digestion, as well as a disordered state of other functions of the body, frequently produces the same effect.

The susceptibility of the pulp to impressions of heat and cold and of acids is always increased by heightened irritability. When this exists to any considerable degree the mere contact of these agents with the tooth is often productive of severe pain, which on their removal very soon subsides. The pulp, however, may remain in this condition for months, and even years, without becoming the seat of inflammatory action.

Preternatural sensibility of the dentine, whether in a sound or partially decomposed state, augments very appreciably the irritability of the pulp. The sensibility of dentine is sometimes so much increased that the mere contact of any hard substance with a part which has become exposed by the destruction of a portion of the enamel is often productive of severe pain. Impressions of heat and cold conveyed through the conducting medium of a metallic filling, or through a thin covering of dentine, as sometimes happens when a considerable portion of the tooth has been worn away, is a very frequent cause of heightened irritability of the pulp. With its susceptibility thus increased, the impressions produced by these agents are often a source of irritation and even of inflammation and suppuration, causing the death of the entire crown and inner walls of the root of the tooth. At other times the irritation is only followed by slight increase of vascular action and an effusion of plastic lymph over the affected part of the pulp, which is gradually converted into *osteo-dentine*; and thus a barrier is interposed between it and the irritating agents.

Hyperemia and Irritation.—The pulp of a tooth may become the seat of severe pain even when there is no inflammation. The slightest increase of vascular action, a condition known as *hyperemia*, when this organ is in a preternaturally irritable condition, is productive of more or less irritation. The pressure of even slightly distended vessels upon the nervous filaments distributed upon it, at such times, is sufficient to cause pain.

Hyperemia of the dental pulp may exist in any degree, according to the increased amount of blood which expands its vessels. The coronal portion of the pulp, what is generally known as its "bulb," exhibits the greatest distention under such conditions, and the pain resulting is often sharp and lancinating, and even paroxysmal in character. The pain from hyperemia is often referred to other organs, such as the ear, face, and in fact to any part of the distribution of the fifth pair of nerves. Hyperemia may result in diffuse inflammation of the pulp when the red blood-globules escape through the pulp-tissue, which generally occurs at the point where the distention is greatest. This condition is liable to occur in sound teeth as well as in carious ones, although the approach of caries to the pulp-chamber is perhaps, the most frequent cause of irritation of the pulp. Within certain limits hyperemia is a physiological condition, an impression induced by a temporary excitant, which soon passes away without injury to the parts involved. But when the cause is sufficient to bring about repeated attacks, the vessels of the pulp fail to contract, and remain distended with blood, and the affected organs become very susceptible to even slight thermal changes, and the hyperemia becomes pathological instead of physiological. The treatment for hyperemia or irritation of the dental pulp consists in the removal of the cause of irritation and the protection of the tooth from all thermal and other influences which may cause irritation, by disinfecting and filling the cavity. In the case of very sensitive teeth the use of non-conducting filling materials, such as gutta percha, or the oxyphosphate or oxychlorid of zinc preparations is indicated; in cases of otherwise healthy and sound teeth they should be protected from thermal changes until the susceptibility to such influences has passed away. Dr. G. V. Black recommends for the latter case a closely-fitting gutta-percha cap as a protection.

Impressions of heat and cold are conveyed more readily to the pulp when the dentine is in a morbidly sensitive condition, and when this is the case they produce a more powerful effect.

The remedial indications of pain in a tooth arising simply from irritation of the pulp, consist in the removal of the primary and exciting causes. When produced by impressions of heat and cold conveyed to it through the conducting medium of a metallic filling and intervening super-sensitive dentine, if the severity and continuance of pain is such as to warrant the belief that it will give rise to inflammation, the filling should be removed and some non-conducting substance placed in the bottom of the cavity before replacing it. If this is done before inflammation actually takes place it will prevent subsequent irritation from these causes. It is worthy of remark, however, that the

pain thus produced is in proportion to the sensibility of the subjacent dentine. If this is destroyed previously to filling the tooth, irritation of the pulp will be as effectually prevented as by the interposition of a non-conducting substance. But in the application of agents for this purpose there is danger of destroying the vitality of the pulp. The employment of them, however, is resorted to more frequently to prevent pain during the removal of caries than to relieve any subsequent irritation from impressions of heat and cold. (See Hypersensitive Dentine.)

Although a frequent cause, yet a metallic filling is not the only medium through which impressions of heat and cold are conveyed to the dental pulp. When the dentine on the coronal extremity or side of a tooth becomes very thin from loss of substance occasioned by mechanical abrasion or erosion, by the use of a cutting instrument, or other cause, the pulp sometimes becomes painfully susceptible to the action of these agents. Loss of substance from any of these causes is also often attended by exalted sensibility of the exposed dentine; and when this is the case the contact of acids with it is productive of more or less pain. Nature, however, usually prevents the painful consequences that would naturally arise from continued abrasion of the coronal ends of the teeth, and the consequent exposure of their nervous pulp, by the gradual ossification of this organ; so that by the time it would become exposed it is converted into osteodentine. But this does not always take place in time to prevent irritation and pain.

When irritation of the pulp occurs in a tooth that has been so much cut away as to leave only a thin covering of dentine over the pulp, the best known means of preventing morbid sensibility is to keep the cut surface constantly clean by frequent friction with a brush and waxed floss silk, or with some other suitable substance. This operation should be repeated after each meal, and in the morning immediately after rising, and at night before going to bed. The application of nitrate of silver for sensitiveness arising from loss of substance or from exalted sensibility of exposed dentine, has proved successful. The nitrate in the solid form may be applied by enveloping a portion of the stick with wax, which will enable the operator to handle it with impunity. Or the end of a silver wire may be dipped in nitric acid and the application be thus made to the sensitive surface, taking care to protect the adjacent parts. Some are in the habit of applying salt as soon as the sensitive surface has been touched with the nitrate, to neutralize its effects. To prevent contact with the gum, when it is necessary to apply the nitrate to the necks of the teeth, a coating of collodion may be painted on them with a camel's-hair brush. But discoloration may

result from such an application. Chromic acid has also been used in these cases with success.

The careless use of the burr, and also of sand-paper discs, in the dental engine, may also induce irritation of the dental pulp on account of the heat generated by such agents.

When caries has extended to the central cavity, irritation is often produced by contact of partially decomposed portions of dentine or other foreign matter with the pulp. The proper remedial indication in such cases, it is scarcely necessary to say, consists in the removal of all matter from the teeth that can either act as a mechanical or chemical irritant. This done, the cavity in the crown of the tooth, supposing the pulp to be in a healthy condition, should be properly filled.

But when the irritation arises as a consequence of exalted irritability and increased vascular action of the pulp, dependent upon disease or altered function of some other part or parts of the body, the remedial indications are different. The treatment then should be addressed to the primary affection. Examples of this sort are of frequent occurrence. They are met with almost daily, particularly in females during gestation, in dyspeptic individuals, and in persons affected with gout and chronic rheumatism. They are also sometimes met with in individuals who have been exposed to miasmatic emanations of marshy districts, when the irritation assumes an intermittent form, occurring at stated intervals of twenty-four, forty-eight, or seventy-two hours, and continuing from one to three hours. Some of the worst forms of toothache are produced by one or other of these causes.

The local disturbance, when it occurs in females during pregnancy, may generally be removed by mild aperients, warm foot-bath, and anodynes at night on going to bed. When it depends upon other kinds of derangement of the uterine organs, treatment suited to the peculiar indications of the case should be instituted. When it occurs in a person affected with dyspepsia, rheumatism, or gout, the constitutional treatment required by the particular disease constitutes the proper remedy. When the irritation assumes an intermittent form, an emetic or cathartic, followed by quinine, will generally put a stop to the local disturbance, provided it has no connection with caries of the crown of the tooth.

INFLAMMATION OF THE PULP—PULPITIS.

The pulp of a tooth, when healthy, has a grayish-white appearance, and its capillaries are invisible to the naked eye, but when it becomes the seat of *acute* or *active* inflammation, they may be distinctly seen, as the organ then assumes a bright red color. Inflammation, having established itself, soon extends to every part of the pulp, and even to

the peridental membrane. When permitted to run its course uninterruptedly, it usually terminates in suppuration in from three to eight or ten days.

The unyielding nature of the walls of the cavity in which it is on all sides inclosed renders expansion of the pulp impossible, and as its capillaries become distended with blood, they press on the nervous filaments which are everywhere distributed upon it, causing at first constant gnawing pain, which afterward, as the distention of the vessels increases, becomes severe, deep-seated, throbbing, and sometimes almost insupportable.

Inflammation may attack the pulps of sound teeth as well as those affected with caries; but it occurs more frequently in the latter than in the former, and it is oftener met with before than after the pulp has become actually exposed. The severity of the pain, however, is determined by the condition of the tooth, the state of the general health, and the causes concerned in its production. The pulp, when in an irritable condition, is more liable to become the seat of acute inflammation than when in a perfectly healthy state, and the occurrence of suppuration is soon followed by alveolar abscess, unless an opening is made immediately through the crown, neck, or root of the tooth, for the escape of the matter.

The effusion of lymph, which takes place during the inflammatory stage, and which, under other circumstances, and when the inflammation is less severe, is made to play an important part in the reparation of the injury, compresses the pulp into still narrower limits as it accumulates in quantity, and thus becomes an additional source of irritation, adding fuel to the flame already lighted up.

Inflammation of the pulp may be caused by a blow on the tooth; by impressions of heat and cold conveyed to it through the enamel and dentine, or through a metallic filling; or by the pressure of a filling, or the direct contact of external irritating agents, such as disorganized portions of the tooth, particles of alimentary substances, acrid humors, etc. But, as we have stated in another place, *inflammation* of the dental pulp is not always a necessary consequence of impressions of heat and cold; pain may be produced by them when pulpitis does not exist; but in this case it usually subsides soon after the removal of the irritant. The exposure of the pulp by decay is a common cause of inflammation of the organ, also abrasion and the careless preparation of a cavity for the insertion of a filling, although in rare cases the pulp of a tooth may be exposed for months, and subjected several times a day to the actual contact of foreign bodies, without becoming the seat of acute inflammation. The irritation and increased vascular action thus occasioned are, no doubt, removed by the effusion of lymph to which they

give rise, and the pulp, after it has become exposed, having room to expand as its vessels become distended, does not suffer irritation from the pressure to which it would otherwise be subjected.

Where suppuration takes place, the pain very nearly ceases, but the tooth for a time remains sore to the touch, and its appearance is changed. It has no longer the peculiar animated translucency of a living tooth, but has assumed an opaque, muddy or brownish aspect. With the disorganization of the pulp, the entire crown and inner walls of the root lose their vitality; still, if the peridental membrane has not become seriously involved in disease, the vascular and nervous supply furnished to the cementum is often sufficient to prevent the tooth from exerting any injurious influence upon the surrounding and more highly vitalized parts. The cementum, being more analogous in structure to true osseous tissue than dentine, now plays an important part in the animal economy. It being more liberally supplied with vitality and with nutritive fluids, and not being sensibly affected by the death of the other parts of the organ, it keeps up the living relationship of the tooth with the peridental membrane, at least sufficiently to prevent it from acting perceptibly as a morbid irritant.

Inflammation of the pulp of a tooth, besides the local pain with which it is attended, often gives rise to a train of constitutional morbid phenomena, usually of a mild, but sometimes of an aggravated and even threatening character. Among these are *headache, constipation of the bowels, furred tongue, dryness of the skin, quick, full and hard pulse, earache, ophthalmia, disease of the maxillary sinus*, etc.

The amount of constitutional disturbance arising from inflammation of the pulp of a tooth depends on the state of the general health, and the nervous irritability of the system at the time. In the majority of cases it may occasion but little inconvenience, and disappear as soon as the inflammation ceases, but sometimes it assumes a very alarming character. A fatal case of tetanus, produced by inflammation of the pulp of a lower molar, occurred a number of years ago in Baltimore. The subject was a young lady about eighteen years of age. The system at the time, from great bodily fatigue and mental excitement, was in an exceedingly irritable condition, but in other respects, though constitutionally rather delicate, she was in the enjoyment of good health.

There is not an organ or tissue of the body in which acute inflammation is more intractable in its nature and rapid in its progress, than in the pulp of a tooth; and when we take into consideration its situation, and its physical and vital peculiarities, it is not to be wondered that it should, in so large a majority of the cases, termi-

nate in the disorganization of the part. Still, it may sometimes be arrested, and the remedial indications here, though they cannot be as readily and fully carried out, are the same as for inflammation in any other part of the body. The first and most important one consists in the removal of all local and exciting causes. For simple exposure of the pulp, without sloughing, the first step, after removal

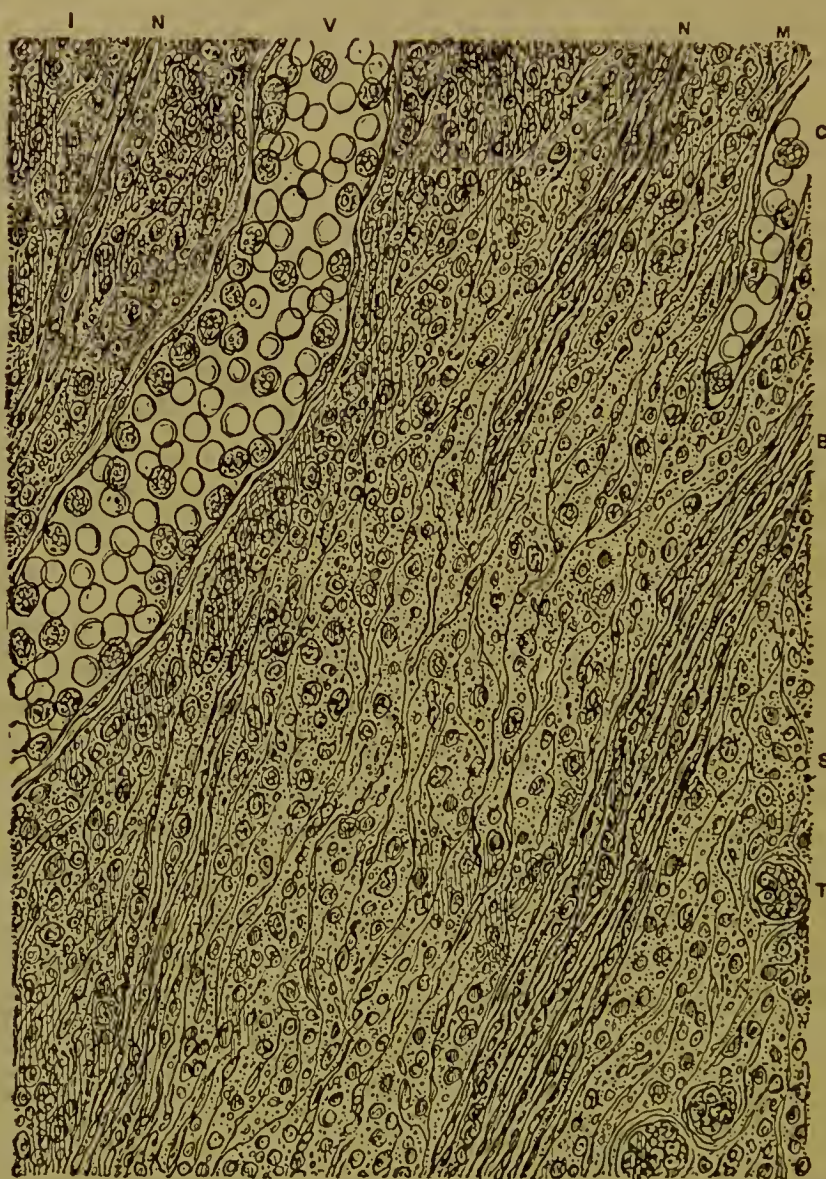


FIG. 124 REPRESENTS AN AREA OF PULP AFFECTED WITH ACUTE PULPITIS. (After Bodecker.)

I. Intensely-inflamed portion. M. Moderately-inflamed portion. S. Slightly-inflamed portion. N, N. Small bundles of medullated nerves, slightly inflamed. T. Nerve-bundle in transverse section. V. Vein, engorged with red and colorless blood-corpuscles. C. Capillary, engorged and widened. Magnified 500 diameters.

of all irritants from the carious cavity, is to attempt the reduction of inflammation and the prevention of the effusion of serum or lymph, by cleansing the exposed surface with tepid water, and, after careful drying, to bathe it with dilute tincture of aconite, when it may be

covered with a thin coating of a solution of gutta-percha in chloroform, or glycerin, or collodion carefully applied, and the tooth protected from irritation. Some prefer the use of a preparation composed of crystallized carbolic acid rendered fluid by a small quantity of chloroform. This preparatory treatment, if successful, is to be followed by the process of "capping the pulp," as described in another place. If it be the result of irritation produced by the pressure of a filling, the plug should be immediately removed, leeches applied to the gum of the affected tooth, and, if the patient be of a full habit, blood may be taken from the arm, and a brisk saline purgative prescribed. The removal of the filling, however, when the inflammation has previously made much progress, will not prevent suppuration, but it may keep it from extending to every part of the pulp. When an external opening is made for the escape of the matter, the moment suppuration takes place the remaining portion of the pulp will be relieved from the pressure which caused the irritation, and then the inflammatory action may cease. But if the matter remains in the central cavity of the tooth, the part of the pulp which has not suppurated will still be subjected to pressure, and the inflammation and suppuration will go on until the entire organ perishes. Nor will the disorganizing process stop here. The periodontal membrane at the extremity of the root will soon become implicated, and in a short time alveolar abscess will form, thus terminating the acute stage of the disease.

There may be no indication of irritation or inflammation for several weeks, or even months, after a tooth has been filled; but at the expiration of this time the pulp, from increased irritability, caused perhaps by some change in the state of the patient's general health, may be attacked by inflammation. Although this very seldom happens, it does, nevertheless, sometimes occur. When there is reason to apprehend that it is about to take place—and it may be suspected if pain is felt in the tooth when anything hot or cold is taken into the mouth, or if it becomes the seat of gnawing or gradually increasing pain—the filling should be removed. If the pain now ceases, a thick layer of gutta-percha dissolved in chloroform, or Hill's stopping, or oxychlorid or oxyphosphate of zinc preparation, may be placed in the bottom of the cavity and the filling replaced; using the precaution, as before directed, to introduce the gold in such a way as to prevent the liability of depressing the floor of the cavity; or a temporary filling of some plastic, non-irritating substance, such as Hill's stopping or chloro-percha, may be inserted and permitted to remain for some time, when a more durable filling may be introduced. But if the pain and inflammation continue unabated, and the application of such escharotics as

carbolic acid, chlorid of zinc, nitrate of silver, and chromic acid, fails to reduce the congestion, it may be necessary to expose the pulp and destroy its vitality. When this is done it is usually with the view of securing the retention and preservation of the tooth by filling the pulp-cavity and root.

It is not advisable to attempt to preserve the vitality of the pulp when it is affected with the diffuse form of pulpitis. The pulp in such cases should be completely extirpated and the pulp-canal be thoroughly disinfected and filled. A purulent condition of the pulp is evident when pus oozes from the pulp-chamber as soon as it is opened, and relief from pain ensues almost instantly. The treatment of such cases consists in removing the putrescent pulp and disinfecting and filling the pulp-canal.

Chronic inflammation of the dental pulp often occurs where the pulp-chamber of a tooth has become gradually exposed by caries of the dentine ; and when this happens the action of the fluids of the mouth, and of other foreign substances which obtain access to the cavity, as well as of the decomposed portions of the tooth-substance, causes an increase of vascular action in the exposed part, followed very often by a slight discharge ; but the morbid action thus induced is comparatively seldom accompanied by pain. The pulp may remain thus partially exposed for months, and even years, without causing any other inconvenience than a momentary twinge of pain when some hard substance is accidentally introduced into the cavity of the tooth, which subsides immediately after its removal. Sooner or later, however, the pain thus excited will become more permanent, continuing each time it occurs from five to ten minutes to one or more hours after the cause of the irritation has been removed. If a tooth be filled under such circumstances, the pressure of the fluid upon the pulp, which is poured out from its exposed surface beneath the filling, will give rise to a more general and active form of inflammatory action. Pain, too, is often experienced before actual exposure of the pulp occurs.

The liability of the tooth to ache increases as the pulp becomes more and more exposed by the gradual decomposition of the dentine ; and the inflammation may ultimately assume a more active form, when the pain becomes very acute, owing to the consequent effusion into tissue surrounded by unyielding walls, or the pulp may become the seat of fungous growth, or it may be absorbed or destroyed by ulceration, or by gangrene and mortification. Cases sometimes occur in which the disease is attended with severe darting pains, often occurring several times in the space of two or three minutes, succeeded by intervals of perfect ease for many hours. At other times it is attended by dull, aching pains, aggravated by taking sweet or acid substances into the

mouth. In cases of this sort the application of heating or stimulating substances to the exposed surface of the pulp will usually procure relief. Permanent exemption from pain, however, is not always obtained, and sooner or later it may become necessary either to destroy the pulp or to extract the tooth. In some cases, however, where the pulp becomes exposed by the action of caries, no pain is experienced except by contact of foreign substances with the exposed surface.

The body of the pulp, when the organ becomes exposed from a decayed opening in the grinding surface of a molar, is sometimes absorbed, while its prolongations in the roots often remain unchanged for two or more years.

Long exposure of the pulp is usually attended with *ulceration*—a disorganizing process, which often causes the destruction of a large portion of the part occupying the central chamber of the crown of the tooth, making in it numerous little excavations. The ulcerated surface usually presents a yellowish appearance, that of an irritable ulcer, with the exudation of a serous or sanguino-serous fluid, a condition, however, which must not be confounded with a state of suppuration. The exuded fluid is very offensive, as it rapidly decomposes, and its reaction is alkaline; when the disorganizing process is arrested before it has effected the destruction of any very large portion of the pulp, the remaining portion usually becomes covered with healthy granulations.

When the inflammation occurs in cachectic individuals it often assumes an acute form, and sometimes terminates in gangrene and mortification. The loss of vitality may be confined to the body of the pulp, or it may extend to every part of the organ. In the former case the pain continues, but in the latter it ceases as soon as mortification takes place. When this happens, the entire pulp, which has now a dark-brown or black color, may be removed. But this is not a very common termination.

The symptoms of chronic as well as acute inflammation are always modified by the state of the general health, habit of body, and the temperament of the individual. The pain attending the former, however, is periodical, occurring at irregular and uncertain intervals, and constitutes that variety of toothache so often relieved by local applications; whereas, in the latter, it is constant.

In chronic inflammation, which implies a state of ulceration, the pulp is either actually exposed or only covered by decomposed or partially decomposed dentine, and the diseased surface rarely embraces a larger circumference than that described by the bottom of the decayed cavity. The inflammation, therefore, is local as well as chronic, but, nevertheless, it is often of so persistent a character as to render

its removal exceedingly difficult. The dentist, however, is not so much restricted in the application of remedies as in the treatment of acute inflammation, and to the action of which it yields more readily. But notwithstanding all this, he will necessarily encounter difficulties in his efforts to subdue it. A greater length of time is sometimes required than the patient is willing to give ; and the opening through the crown to the central cavity is frequently too small, previously to the removal of the partially decomposed dentine, to admit of the direct application of the necessary remedial agent to the inflamed surface of the pulp. Again, it often happens that the situation of the tooth and cavity are such as to prevent a complete view of the diseased part. It is important that the operator should get such a view to enable him to determine whether the inflamed surface is ulcerated, or pours out a serous fluid ; or whether the morbid condition is simply one of irritation, produced by the presence of acrid matter, or of partially or wholly decomposed dentine. Unless his diagnosis is correct, his prescription will be as likely to do harm as good ; but, having ascertained the exact character of the disease, he may often be able to institute treatment that will result in the restoration of the pulp and the preservation of the tooth.

It is important, too, to understand the part which nature plays in the curative process ; for cure here, as in other parts of the body, is effected by that internal force which, as Chomel says, “presides over all the phenomena of life, contends unremittingly with physical and chemical laws, receives the impressions of deleterious agents, reacts against them, and effects the resolution of disease.” This vital force is sometimes exercised in the cure of disease in the pulp of a tooth, but more frequently in its prevention ; as is shown by the gradual ossification of the organ in those cases where it would otherwise become exposed by mechanical or spontaneous abrasion of the solid structures which enclose it ; and occasionally by the formation of secondary dentine upon the surface of the original or primary dentine at a point toward which the caries is advancing. Nature, no doubt, would always provide in this way against the exposure of the pulp, if the occurrence were always long enough preceded by sufficient irritation or increase of vascular action in it to call her energies into operation. But the formation of osteo-dentine, which constitutes the protective wall of defense, is a tardy process, and, as a general rule, proceeds more slowly than the caries in the tooth, which causes the exposure of the pulp. Besides, it often happens that the approach of the caries is not announced by the slightest irritation, a condition necessary to the new formation of dentine, until it reaches the central cavity. At other times the approach of the disease gives rise to too much irritation,

a condition equally unfavorable to the dentinification of the pulp. Thus, no protective covering being formed, it soon becomes exposed, when it is subjected to the action of such irritating agents as may chance to be brought into contact with it. Hence its liability to become the seat of chronic inflammation as well as other forms of diseased action.

If the disease is attended with pain, the removal of this must first claim attention, and should be effected with as little delay as possible; otherwise the morbid action may extend to every part of the pulp and peridental membrane and assume a more active and unmanageable form. If the pain is the result of irritation produced by the direct action of mechanical or chemical agents, the cavity in the tooth should at once be carefully freed from all extraneous substances and decomposed portions of dentine. This done, a dossil of raw cotton or lint—saturated with spirits of camphor, laudanum, sulphuric ether, chloroform, creasote, or some one of the essential oils—may be applied. The following anodyne application has been employed with advantage to relieve the pain arising from congestion of the pulp: Cotton saturated with a solution composed of alcohol, 1 ounce; chloroform, 2 ounces; ether, $\frac{3}{4}$ ounce; gum camphor, $\frac{1}{2}$ ounce; tincture of opium, $\frac{1}{2}$ ounce; and oil of cloves, 1 dram. When the pain is relieved another application, consisting of carbolic acid and oil of cloves, is made and permitted to remain for some fifteen minutes. A paste composed of iodoform and glycerin is also employed after the active symptoms of congestion have subsided.

For the treatment of wounded and irritated pulps the tincture of calendula proves a very useful remedy. Such agents as glycerole of thymol, carvacrol, oil of eucalyptus, tannic acid, lead water, morphine, creasote, chloral, and tincture of aconite have also been found serviceable in the treatment of inflamed conditions of the pulp.

When the irritation is produced by acidulated buccal fluids, the application of carbonate of soda, or some other alkali—tepid water containing sufficient carbonate of soda to make it slightly alkaline—will often give immediate temporary relief; but as the condition of the secretions of the mouth, especially the salivary, is usually acid, owing to gastric derangement, the correction of this constitutes the first and most important remedial indication. When any application is made to the pulp for the purpose of removing irritation and pain, its full effect will not be obtained unless the fluids of the mouth are excluded from the cavity of the tooth; this may be done by closing the orifice with softened wax, or cotton saturated with the sandarach solution, using the precaution not to force it so far as to press the application previously made upon the exposed pulp.

Suppuration of the Pulp.—Independent of the condition known as alveolar abscess, the pulp of a tooth is liable to suppuration when exposed for a considerable time, by the formation of either an abscess within its substance, or, more frequently, by a superficial suppression on its surface.

In such cases, layer after layer of the substance of the organ is destroyed at the point of exposure, and inflammatory elements or products take their places. The layer of odontoblasts is disorganized as a result of superficial inflammation, and becomes a mass of sanious pus filled with micro-organisms. Deep pockets are formed in the substance of the pulp by the suppurative process, and a section of the organ is progressively destroyed from the exposed surface in the direction of the root. This progressive suppuration and destruction may continue until a small portion only remains in the apical portion of the root-canal, or the entire organ is destroyed. Many histologists are disposed to question the theory that the dental pulp ever recovers after suppuration is once established in it, while some contend that cicatrization and ability to perform its functions are possible after such attacks.

Suppuration of the pulp generally commences in the form of small collections of pus within the layer of odontoblasts which may retain their distinct forms for some time, when they may coalesce. Deeper in the structure of the pulp a large abscess may undermine the layer of odontoblasts, and if the pus generated under such circumstances is greater in quantity than the cavity for its retention, compression and strangulation of the pulp result, causing the destruction of the organ. The pain accompanying abscess of the pulp generally commences with a slight gnawing sensation, which persistently increases in severity until it becomes very excruciating. When decomposition of the entire pulp occurs, gas is generated, which, by its pressure, gives rise to severe pain, and the trouble is only relieved by a vent being made for the escape of the gas and secretion. It is seldom, however, that gas is formed within the living pulp, although there are cases sometimes met with where gas is generated in a closed pulp-cavity during the progress of the suppuration in the pulp. A small amount of pus in a pulp-chamber may undergo absorption, for even fatty degeneration, but such cases are rare.

The causes of putrescent pulps may be enumerated as follows: Mechanical violence, such as blows; the careless regulating of teeth; the rapid separation of teeth by wedges, screws, etc., or separation by any method when the condition of the system contraindicates such an operation; thermal influence through a metallic filling, and especially

in the case of young teeth ; exposure of the pulp to irritating agents. A dead pulp may remain quiet for months, or even years, and if not exposed by caries, even for many years, but the action of the atmosphere may in a very short time cause inflammation of the peridental membrane ; hence it is often a question whether teeth in which dead pulps are quiescent should be interfered with. But as all such teeth are liable to cause periodontitis and alveolar abscess, the treatment of such cases, where no exposure exists, is to make an opening with a drill into the pulp-chamber, the entrance of the instrument being easily recognized by its sudden opening into such a space.

When this is effected, an antiseptic agent, such as oil of eucalyptus, iodoform in the form of an ethereal saturated solution, or permanganate of potash, etc., etc., should be introduced into the pulp-cavity, taking care to leave a vent through the temporary filling which is to confine the antiseptic agent. The remains of the devitalized pulp should be removed at a second sitting by means of a barbed broach, and the pulp-canal thoroughly disinfected. Such treatment should be continued until all odor of decomposition has disappeared, and the cavity will permit of being closed tightly without trouble ensuing. The antiseptic agent must be thoroughly applied, so that it may pass into every part of the pulp-cavity and the dentinal tubes. It should be remembered that the product of decomposition, which is principally sulphuretted hydrogen exhibited in the form of gas, is not only rapidly developed, but exerts great pressure in the apical space ; hence the roots of a tooth thus affected should not be filled until there is every reason for believing that the decomposition has been overcome. It may be necessary in these cases to continue the disinfectant and antiseptic treatment for several weeks before filling the pulp-cavity, although immediate root-filling, even in such cases, has its advocates.

Atrophy, or Degeneration of Structure.—This condition may result from a low degree of inflammation of the pulp when long continued, which has the effect of so reducing its volume that it presents a shriveled appearance, and to which the term “mummified” has been applied.

The pulp-cavity in such cases is entirely free from any products of decomposition, and the tooth retains its natural color. This affection appears to be more common to teeth of a dense structure, and has been ascribed by writers on this subject to a gradual obliteration of the tubuli by a deposit of secondary dentine, which interferes with nutrition to such a degree as to produce attenuation. The original cells of the tissue disappear and are changed into fine fibres, and areolæ are developed in the matrix, and the sensibility of the pulp is either greatly diminished, appearing like a thin, flattened thread, or

altogether destroyed, the latter being the condition of completely mummified pulps. Wedl attributes this atrophy to a withering of the reticulated connective-tissue cells, together with the peripheral blood-vessels and nerves. Dental pulps in such a condition may never become a source of irritation, if atmospheric germs are not admitted by the opening of the root-canals, and the only treatment required is the removal of the remains of the attenuated organ and the disinfection and filling of the root-canals.

Disorganization, or Gangrene.—The disorganization of the pulp of a tooth is generally the result of acute pulpitis where micro-organisms gain access to the inflamed pulp, which is transformed into a dark-brown or grayish fetid mass, the odor being due to the generation of putrefactive gases. The accumulation of these gases in the pulp-chamber, it is claimed, has caused the bursting of the crown of the teeth with a loud sound. Dry gangrene of the pulp is a condition due to the obstruction of the afferent artery, as by an embolus or blood-clot. The pulp when in this condition presents the appearance of a grayish-white dry substance, without odor. In all of the cases which have attracted the attention of the author, the disorganization has been carried on so insidiously that neither the presence of disease nor structural alteration was suspected until the teeth assumed a dull brownish or bluish-brown appearance. The death of the pulp had not been preceded in any of these cases by the slightest indication of inflammatory action. It had apparently resulted from want of sufficient vital energy to sustain the nutritive function.

The alveolar cavities of the affected teeth in these cases were, seemingly, in a healthy condition—a circumstance which, when we take into consideration that the parts of the extremity of the roots were exposed to the action of the disorganized remains of the dental pulps, may appear somewhat strange. But this may have been owing, partly, to diminished excitability in the peridental membrane, and partly to the smallness of the quantity, and the innocuous character of the matter contained in the central cavities of the teeth. The gums of that portion of the alveolar border occupied by the affected teeth had a pale, grayish-purple appearance, but exhibited no indications of actual disease. They were as thin and their margins as distinctly festooned here as in any other part of the mouth. In some instances, the teeth had been in this condition for seven or eight years.

The remedial indications in cases of this kind are the removal of the pulp and the disinfection and filling of the root canals.

Fatty Degeneration.—This affection of the pulp, according to Wedl, is of frequent occurrence. The fatty pulp presents a cloudy appear-

ance, and under the microscope appears to be full of fat-granules in all of its constituent elements.

This condition is also observed in deciduous teeth when their roots are undergoing the process of absorption.

Fungous Growth.—The pulp of a tooth, when exposed by decay of the crown, sometimes becomes the seat of a fungous growth, in the form of a small vascular tumor, the formation of which is caused by constant irritation. These morbid growths sometimes attain the size of a large pea, completely filling the cavity made in the crown of the tooth by caries; at other times they do not exceed that of a small elderberry. The former have little sensibility, and bleed freely from the slightest injury; the latter are less vascular, but are nearly as sensitive as the pulp in a healthy state.

It often happens that a fungous growth of the gum or peridental membrane, finding its way through an opening in the side of the neck or root of a decayed tooth, appears in the central cavity, and is sometimes mistaken for a morbid growth of the pulp. But the character of a fungous growth or polypus of the pulp can be readily determined by its attachment to the portion of the organ occupying the pulp-chamber by a constricted neck. Such fungous growths have a dark-red color and a fleshy or spongy consistence. Such fungous growths are more common to the pulps of the inferior molar teeth when caries has hollowed out the crowns to a considerable degree. Such tumors usually grow very fast, and sometimes attain the size of a hickory nut. They are exceedingly vascular, bleeding profusely when wounded, and are soon reproduced after removal. The author has met with tumors of this kind which had originated in the peridental membrane of the extremity of the alveolar cavity.

Where there is a tendency to fungous growth of the pulp, the application of an escharotic has proved serviceable. Of these agents chromic acid appears to be very effective.

Another method is to apply carbolic acid freely to the fungous growth, to obtund its sensitiveness, excise it, and then make an application of nitric acid on a disc of card-board. A method of treating such a fungous growth is described by Dr. Maercklein as follows: After carefully removing all foreign substances and carefully drying the cavity, apply the tincture of iodine with a pledget of absorbent cotton or bibulous paper until the entire growth is covered with the iodine; after which seal the cavity in the usual manner. This should be repeated every twenty-four hours until it has been completely destroyed. If the fungous growth should fill the entire cavity, take small pledgets of the paper or cotton saturated with the iodine and

place them between the fungoid and the walls of the cavity until as much pressure has been made as is consistent with the comfort of the patient, but in no case giving pain. This dressing is repeated daily until sufficient room has been obtained to proceed as in the first case.



FIG. 125.—PULP WITH PULP STONES. C. C. Calcareous globules. L. Lymph vessel. N. N. Bundles of medullated nerves magnified 10 diameters.

It frequently happens, however, that teeth with pulps in this condition are too far gone to justify their retention.

Calcareous Concretions.—Calcareous depositions in the shape of nodules and irregular needles or spiculæ are often found in the pulp, and

are ascribed to a calcification of the cells or to a direct impregnation of the organic substance with lime salts. Fig. 125 (after Bödecker) represents a pulp with the so-called pulp-stones imbedded in its substance.

The age of the person does not appear to influence the formation of these calcic deposits, as the teeth of both young and old are subject to calcification. Calcified pulps contain more fibrous connective tissue than myxomatous tissue, and Bödecker states that “invariably around the calcified masses a dense layer of fibrous connective tissue has formed, ensheathing the calcified masses.” “Where these masses” (or pulp-stones) “have fallen out an empty fibrous sac is left behind, in which there are neither endothelia, so characteristic of blood-vessels, nor oblong nuclei, which we see in the external perineurium of the bundles of medullated nerve-fibres. The presence of this envelope may convey the idea (especially if the calcified masses are elongated and appear like small, lobulated sausages) that an obliteration has first occurred in the blood-vessels by a process which in other vascular systems, mainly that of the lungs, is known as ‘fatty embolism.’” Dr. Bödecker also ascribes the primary cause of calcification in an unerupted wisdom tooth to be embolism of micrococci of an unknown nature in the arteries and capillaries which did not cause pulpitis. Others ascribe the deposit of lime-salts to the plasma of the blood laden with such salts accumulating in the capillaries of the pulp and unable to escape. Fig. 126 represents calcification in the pulp of a first lower molar of a healthy young man eighteen years of age.

Ossification.—Allusion has been made several times, in the course of this work, to the ossification of the dental pulp as a means employed by nature to prevent the exposure of this most delicate and exquisitely sensitive structure. But examples of it are occasionally met with in teeth which have suffered no loss of substance, either

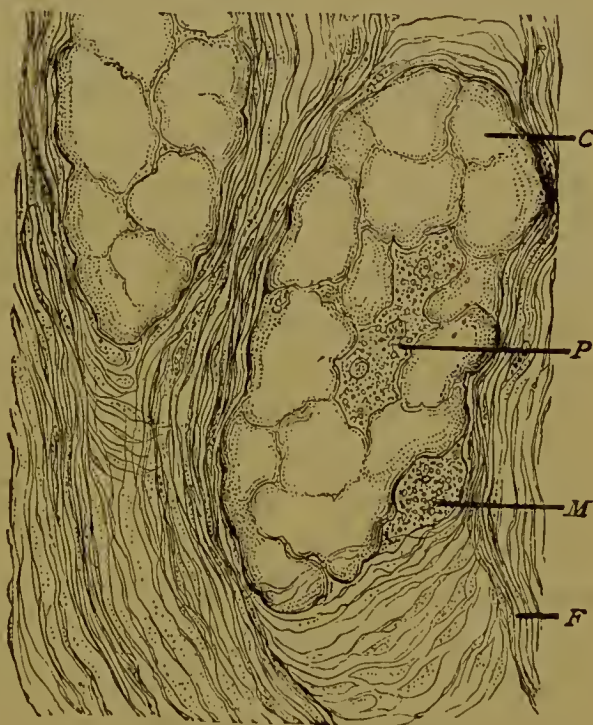


FIG. 126.—CALCIFICATION.

C. Calcified masses of irregular lumps, probably former medullary corpuscles. M. Medullary corpuscles unchanged. P. Central plastid, free from infiltration. F. Capsule of fibrous connective tissue. Magnified 300 diameters.

from mechanical abrasion or from the decay of the dentine. The occurrence, whatever may be the circumstances under which it takes place, is evidently the result of the operation of an established law of the economy, dependent upon moderate irritation and a slight increase of vascular action; ossification having commenced, it usually goes on until every part of the pulp is converted into a substance analogous to cementum. We infer, then, that when the pulp of a tooth becomes the seat of a sufficient amount of irritation, ossification must follow as a necessary consequence; but if the irritation be succeeded by active inflammation, a different result may be expected.

The irritation necessary for the ossification of the pulp of a tooth sometimes arises from constitutional causes; but in the majority of cases it results from the action of local irritants, and most frequently from impressions of heat and cold, communicated through the medium of a metallic filling or a thin layer of dentine.

During the ossification, a sensation is occasionally experienced in the tooth somewhat similar, though altogether less in degree, to that which attends the knitting of the fractured extremities of a broken bone. A numb, vibratory pain, barely perceptible, is first felt passing through the tooth several times a day, but only lasting a second or two at a time. It is often scarcely sufficient to occasion any annoyance, or to attract anything more than momentary attention.

As the ossified deposit increases in size, pain of a neuralgic character may ensue, and similar to the sensation which results from the knitting together of the fractured extremities of a bone, but not constantly severe. At times, however, the pain becomes sharp and darting, affecting the side of the face and head. The treatment consists in the application of an anodyne, such as lead water, about the affected root and the opening of the pulp-chamber, in order to remove the affected pulp, which should be completely extirpated and the root-canals filled.

With the ossification of the pulp, the crown and inner walls of the root lose their vitality, but the appearance of the tooth is not, as in the case of necrosis arising from the disorganization of the pulp, materially affected. The central cavity being filled with semi-transparent osteo-dentine, the crown retains its natural color. The discoloration and opacity attending necrosis produced by other causes result partly from the presence of putrid matter in the pulp-cavity, and partly from its absorption by the surrounding dentinal wall.

Odontalgia.—Pain in a tooth, toothache, or *odontalgia*,* as it is

* So much has been said upon this subject in the consideration of the different forms of inflammation of the pulp in the preceding pages, that but little remains to be noticed.

technically termed, is a symptom of some functional or structural disturbance, either of the organ in which the pain is seated, or of some other part or parts of the body, but more frequently of the former than of the latter. So variable is the character of the sensation, that any description would fail to convey to one who has never experienced it a correct idea of its nature. The pain sometimes amounts only to slight uneasiness; at other times the agony is almost insupportable. It may be dull, deep-seated, boring, throbbing, or lancinating. It may be slight at first, gradually increasing in severity until it amounts to the most excruciating torture, or it may come on without any premonition whatever. It may be confined to a single tooth, or it may affect several at the same time. It may commence in one tooth and pass from thence to another, and continue until every one in turn has been attacked. It may continue for hours and days with scarcely any cessation; or it may be intermittent, the paroxysms recurring at stated or irregular intervals, and each lasting from thirty minutes to one, two, or more hours.

The causes of odontalgia are almost as numerous as are the varieties of character which it exhibits. Irritation and inflammation of the pulp, and inflammation of the investing membrane, are among the most frequent; but it is sometimes referable to a morbid condition of the nerve or nerves going to a single tooth, or of the trunk from which several teeth are supplied; also to derangement of the digestive organs, to increased nervous susceptibility of the uterus resulting from pregnancy, amenorrhea, etc., and to certain diatheses of the general system.

Inflammation of the peridental membrane and pulp may be produced by a blow upon a tooth, or by powerful impressions of heat and cold communicated through the enamel and dentine, or through a metallic filling; but it is more frequently occasioned by pressure, or by the direct contact of irritating agents, such as carious portions of the tooth, particles of food, acrid humors, and other irritating external substances. But inflammation is not always a necessary consequence of such impressions. Pain may be produced by them when inflammation does not exist; in this case it usually subsides soon after the removal of the irritant. Indeed, the pulp of a tooth may be exposed for months, and subjected several times every day to the contact of foreign substances, without becoming the seat of inflammatory action; and in the absence of this, the pain, though coming on with the suddenness of an electric flash, and often of the most excruciating kind, is seldom of long duration.

But when inflammation exists, the pain, which at first amounts only to a slight gnawing sensation, is more constant; after a while it

assumes a throbbing character, and if not promptly arrested it increases in severity and continues until suppuration of the lining membrane and pulp takes place. So long as it is confined to the parts within the pulp-cavity the pain is not increased by pressure on the tooth, nor is the tooth started from the socket, as in periodontitis. The locality of the inflammation may also be distinguished by the fact that cold water or ice applied to the tooth generally gives relief. But the inflammation rarely confines itself long to the interior of the tooth; it usually soon extends to the peridental membrane of the root and its cavity, when a somewhat different train of phenomena are developed. Suppuration, however, having taken place, an abscess soon forms at the extremity of the root.

The severity of the pain attending *pulpitis* is doubtless owing to the fact that this exceedingly sensitive structure, as its vessels become injected, is prevented from expanding by the unyielding nature of the walls of the cavity in which it is situated. Its capillaries being thus distended, must, as a necessary consequence, press upon the nerves which are everywhere distributed through it, and the excruciating painful, throbbing sensation, by which this variety of odontalgia is characterized, is produced by the pulsation of these vessels. Hence, increased action of the heart and arteries, from whatever cause produced, augments the pain; it is also more severe at night, while the body is in a recumbent posture, than during the day, because this position gives an increased fullness to the arteries of the head. The phenomena attending the inflammation, however, are influenced very much by the condition of the tooth and the habit of body of the patient.

When the inflammation is acute it extends to every part of the pulp and lining membrane. It also occurs more frequently before than after these tissues have become exposed, and generally terminates in suppuration. Chronic inflammation usually arises from partial exposure of the pulp, and may exist for months without being attended with pain; but the pulp, when thus affected, is more susceptible to injury by heat or cold and by irritating substances; and the liability of the tooth to ache, especially at night, is greatly increased.

Odontalgia, caused by acute inflammation of the investing membrane, is characterized by pain, at first dull, afterward acute and throbbing, soreness and elongation of the tooth, redness and tumefaction of the gums, and sometimes by swelling of the cheek; indicating the formation of alveolar abscess. In this variety of odontalgia the tooth is often so much raised in its socket as to interfere more or less with mastication.

The pain attending the foregoing pathological conditions, when

severe and protracted, is often accompanied by constipation, headache, dryness of the skin, flushed cheeks, fullness and increased rapidity of pulse, and other constitutional symptoms.

The nervous susceptibility of the teeth is sometimes so much increased by organic and even functional disturbances of other and often remote parts, that the mere contact of the minute nerves of the pulp and the lining membrane against the wall of dentine which encases them is attended with severe pain. This variety of odontalgia is termed *sympathetic*, and is supposed to be the result of the transfer of nervous irritation, or, more properly, of *exalted sensibility* of the dental nerves, arising from a morbid condition or functional disturbance of some other part. If this hypothesis be true, it is probable that with this heightened nervous excitability there is a slight increase of vascular action in the pulp, with a corresponding increase of size in its capillaries; in consequence of which, it is fair to presume the nervous filaments supplying these tissues would be apt to respond painfully to the undue pressure. Though pain arising from this cause may have its seat in sound as well as in decayed teeth, it occurs more frequently in the latter than the former, owing to the fact that any structural alteration in the dentine adds to their already increased nervous excitability.

Persons of highly excitable nervous temperaments, pregnant females, and individuals laboring under derangement of the digestive organs, are particularly subject to this variety of odontalgia. Odontalgia arising from pathological conditions or functional disturbances of other parts assumes a great variety of forms. The pain may be continued, but more frequently it is periodical; it may be confined to a single tooth, or it may attack half a dozen or more at the same time. It sometimes also alternates with the paroxysms of rheumatism or gout, the pain in such cases assuming the specific character of these diseases.

In what is termed neuralgic odontalgia, "the pain," says Dr. Wood, "is usually of the acute character; sometimes mild in the beginning, gradually increasing in intensity, and as gradually declining, but usually very irregular; at one time moderate, at another severe, and occasionally darting with excruciating violence through the dental arches. Not unfrequently it assumes a regular intermittent form. Instead of pain, strictly speaking, the sensation is sometimes of that kind which is indicated when we say that the teeth are on edge, and is apt to be excited by certain harsh sounds, such as that produced in the filing of a saw, or by mental inquietude, and by the contact of acids or other irritant substances. Neuralgic toothache sometimes persists, with intervals of exemption, for a

great length of time. The diagnosis is occasionally difficult. When, however, it occurs in sound teeth, is paroxysmal in its character, is attended with little or no swelling of the external parts, occupies a considerable portion of the jaw, and especially when it alternates or is associated with pain of the same character in other parts of the face, there can be little doubt as to its real nature." This variety of sympathetic toothache is perhaps induced by caries, or by the manner in which the teeth are arranged in the alveolar arch, or by some peculiar susceptibility of the parts; as is shown by the fact that the pain usually ceases on the removal of all such causes of irritation.

But while, on the one hand, pain in the teeth may be caused by a morbid condition of other organs, these organs, on the other hand, frequently sympathize with the diseased condition of the teeth, and become, to quote the language of Mr. Bell, "the apparent seat of pain. I have seen this occur not only in the face, over the scalp, in the ear, and underneath the lower jaw, but down the neck, over the shoulder, and along the whole length of the arm." Cases of this sort are frequently met with.

Mr. Fox gives a striking example in a person from whom he extracted a tooth, which afforded little or no relief; in consequence of which his patient applied to him only two days afterward and requested the removal of several adjoining teeth, which were perfectly sound. This he objected to, and, suspecting the real nature of the disease, he immediately took him to Sir Astley Cooper, who, by dividing the affected nerve, produced a radical cure in a few days. The author is acquainted with a gentleman similarly affected. He has had all his teeth on the right side of both jaws extracted without obtaining any relief.

There is still another cause of odontalgia which we should not omit to mention—hypercementosis; but from the obscurity of the diagnosis, the existence of the affection can seldom be determined with positive certainty, except by the removal of the tooth. In the early stage of hypercementosis, when the trouble is thought to be in a tooth, the only method of relief is to open the pulp-chamber, devitalize and remove the pulp, and fill the root-canals.

Finally, some teeth, from peculiar constitutional idiosyncrasy, are more liable to odontalgia than others. It sometimes happens that every tooth in the mouth is destroyed by caries without being affected with pain, while at other times teeth apparently sound become the seat of the most agonizing torture.

The first thing to be attended to in the treatment of odontalgia is the removal of the causes which have given rise to it; this can only

be done by carrying out the curative and remedial indications of the morbid conditions and functional disturbances with which it is connected. While these continue, it will be impossible to obtain permanent relief. The sensibility of the nerves supplying a tooth may often be obtunded and the pain palliated by the application of stimulating and anodyne agents to the exposed pulp, but the relief thus procured is seldom of long duration. When their effects subside, the pain usually returns with increased severity. When the pain arises from chronic inflammation and irritation, produced by external agents on an exposed portion of the lining membrane, such applications may often be employed with great advantage; and among those which have been used for this purpose are creasote, the oil of cloves, cinnamon, laudanum, spirits of camphor, tannin, ether, chloroform, etc. But of all the remedies prescribed by the author he has found none more useful in allaying the pain than the following:—

℞. Sulphuric ether, ʒj.	℞. Sulphuric ether, ʒj.
Powdered camphor, . . . ʒij.	Creasote, ʒss.
Powdered alum, ʒij.	Ext. of nutgalls, ʒj.
Sulphate of morphine, . gr. ij.	Powdered camph., . . . ʒss.

The alum should be very finely powdered, and all the ingredients well mixed before use.

℞. Chloroform,	℞. Chloral,
Tinct. opii, . . āā . . . ʒij.	Camphor, . . . āā . . . ʒj.
Tinct. benzoin, ʒviij. M.	Morphine, gr. ij.
	Oil of peppermint, . . . ʒij. M.

After removing all foreign matter and carefully drying the cavity of the tooth, a small bit of cotton or lint dipped in either of the above mixtures may be applied, and renewed several times a day, if necessary. The relief obtained is, in the majority of cases, almost instantaneous; but as the effect is only temporary, the pain is apt to recur. The author has sometimes used a solution of gutta-percha in chloroform (chloro-percha). The application of a drop or two of this to the exposed pulp is usually followed by the immediate cessation of pain, and as the chloroform evaporates, a thin layer of gutta-percha remains, and serves for a time as a sort of protection to the pulp.

It often becomes necessary to have recourse to the destruction of the pulp, in order to preserve the tooth and restore its usefulness. This may be effected either by immediate extirpation with a small, sharp-pointed elastic stilet or probe, by the actual cautery, arsenious acid, carbolic acid, cobalt, or chlorid of zinc. Immediate extirpation, or the application of devitalizing agents, are the means usually employed for the purpose.

Pain in a tooth arising from acute inflammation of the pulp and lining membrane can only be relieved by the extraction of the tooth, the destruction of the pulp, or by subduing the inflammatory action; the last can seldom be done except by the most energetic treatment in the very beginning, in cases where the decay has not penetrated to the pulp cavity. The propriety or impropriety of extraction will be determined by the amount of pain, the degree of the inflammation, the condition of the parts with which the tooth is immediately connected, the effect of local disturbance upon the general system, the situation and importance of the tooth, and the extent of structural alteration which has taken place in the crown. If the retention of the tooth, on account of its location, or the loss of several other teeth, is of great importance to the patient, and the circumstances of the case justify a well-grounded belief that it can be preserved and rendered useful without acting as a morbid irritant, extraction should be avoided. In this case, supposing the inflammation to have proceeded too far to be arrested, the pulp may be destroyed and the tooth treated in the manner described in another chapter.

When the inflammation is produced by other causes than exposure of the pulp and the contact of external irritants, it may perhaps be successfully combated. The treatment is similar to that for local inflammation in other parts of the body; the administration of saline cathartics, the application of leeches to the gum of the affected tooth, abstinence from animal food and stimulating drinks. If the pulse is full and hard, blood may be taken from the arm with advantage. Diaphoretics are often beneficial, such as Dover's Powder or Spirit of Mindererus. Bromid of potassium, in doses of gr. v to gr. xl, with a mustard plaster to the back of the neck and a hot foot-bath, together with the local treatment for pulpitis, before described, will often be found efficacious. Should these means fail to arrest the inflammation, and suppuration take place, the formation of alveolar abscess may be prevented by promptly perforating the crown of the tooth for the escape of the matter; but such cases usually terminate in periodontitis, which perhaps arises as frequently from this as from any other cause.

As the treatment of periodontitis or inflammation of the investing membrane is described in another chapter, it is unnecessary to repeat it.

Odontalgia assuming a rheumatic or gouty character, calls for a somewhat different plan of treatment. In addition to the local means already described, it may be necessary to adopt the constitutional treatment applicable to rheumatism and gout. When the pain arises from increased vascular action and nervous irritation of the pulp, occasioned by a disordered condition of the digestive organs, and assumes an intermittent form, an emetic or cathartic, followed by the

use of quinin, will generally afford relief, provided caries has not penetrated to the pulp cavity. If dependent on general nervous irritability of the system, tonics, exercise, change of air, or such other constitutional measures as the peculiarities of the case may indicate, should be recommended.

The extraction of the tooth is the only remedy that can be relied upon for relief of pain arising from hypercementosis when the formation of cementum has attained considerable size. The internal use of iodid of potassium in the early stage of the growth has been suggested.

DEVITALIZATION AND REMOVAL OF THE PULP.

With regard to the best means of destroying the pulp of the tooth, when it is impossible to preserve it, there exists much diversity of opinion. There are two methods by which this may be accomplished, one by immediate *extirpation* with an instrument and by *actual cautery*, the other by the application of some devitalizing agent, such as *arsenic*.

For the removal of the pulp by extirpation there are different forms of instruments employed, such as a three- or four-sided broach, barbed for some distance from the point, which is thrust as far up the pulp canal as is possible, then rotated and withdrawn, bringing the pulp with it. Fig. 127 represents a broach of this kind, which may be used with or without a holder. Another form of broach is used for this operation which is not barbed, but thrust into the pulp for the purpose of so lacerating it that it may afterward be removed with nerve instruments without much pain. A fine, round, steel wire, from which the temper has been drawn, and having a flat point bent on an angle of about forty degrees, is also used for extirpating the pulp.

The edge of the point, in introducing this instrument, is pressed against one wall of the canal and gradually forced up as far as it will enter, when it is suddenly turned so as to excise the pulp and on withdrawing the instrument bring the severed organ with it.

Figs. 128 and 129 represent excellent forms of instruments devised by Dr. R. B. Donaldson for cleansing pulp-canals and removing pulp.

For extirpating the pulps of the molar teeth a larger instrument is required, which is thrust into the pulp-chamber, and rotated so as to sever the body of the pulp from the branches filling the root canals. The small nerve instruments are then employed for removing these branches.

The operation of extirpation should depend upon the temperament of the patient and the condition and class of the tooth. Where such an operation would cause a severe shock, owing to a nervous, irritable temperament, it is best to employ the therapeutical method; on the other hand, where there is great power of endurance, and the tooth is

of a frail, chalky consistence, or threatened with periosteal inflammation, it is preferable to remove the pulp by an operation. The pain, however, can be greatly mitigated by the previous application of some

FIG. 127.



FIG. 128.

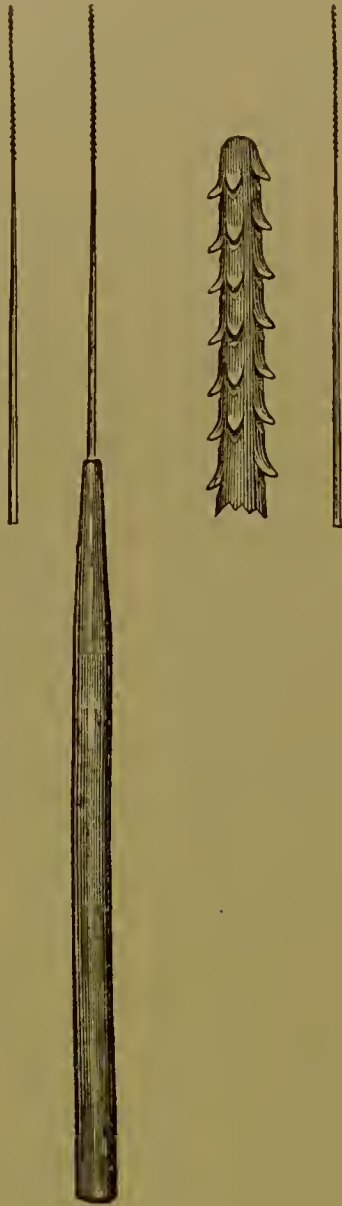
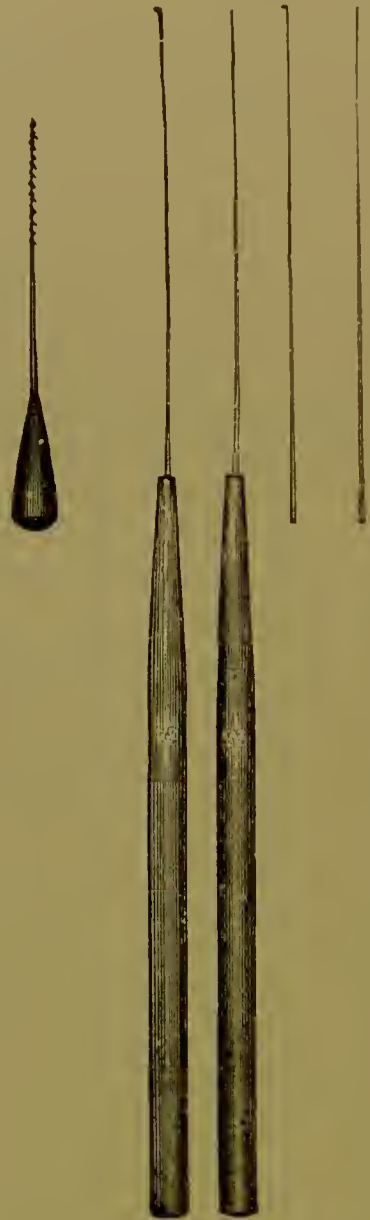


FIG. 129.



obtunding agent, such as sulphate of atropin, aconite, cocain, chloroform, or other local anesthetics.

In all cases, and by whatever method, the orifice of exposure should be large and nearly on a line with the axis of the tooth, so as to admit of easy manipulation, especially if the barbed broach or bent wire are employed; and when a pulp is removed by such an operation the wound usually heals by first intention, and no peridental irritation results.

The late Dr. Harwood, of Boston, who was strongly opposed to the use of arsenious acid as a devitalizing agent, described his plan of accomplishing this object by the surgical method, as follows:—

“I first effect such an opening as will enable me to approach the exposed pulp in the line of its axis, or as nearly so as circumstances will permit. Then, having carefully but sufficiently exposed the surface of the pulp, I pass down to the apex of the root, through the pulp, a small untempered steel instrument, with a trocar-shaped point, and revolving it once or twice sever the vessels and nerve. This, as any one knows who is accustomed to inserting artificial teeth, produces but a slight and momentary pain. I then, by means of minute instruments adapted to the purpose, endeavor to remove every portion of the severed pulp and lining membrane, and, as soon as the hemorrhage ceases, dry and fill the cavity.

“It should be borne in mind that at the point where the vessels and nerve in question enter the root the passage is much smaller than it is immediately within. This strait will be easily recognized, when reached, by the touch, the instrument appearing to be arrested by an obstacle, and not by being wedged in a narrow passage. Care should be taken, I think, that the instrument is not allowed to pass through the strait, either by being too small, or by being revolved there till it cuts its way through. For by wounding the parts without the tooth and forcing particles of bone out upon the parts external to the root the danger of an unfavorable result would be greatly increased.”

The actual cautery consists in thrusting a wire, heated to a white heat, up the canal; but as this is considered a barbarous method, it is not resorted to by practitioners in this country. Besides, peridental inflammation is often a result of its use, and the pain following its application is sometimes very severe. The galvanic cautery is preferable to the actual cautery for the destruction of pulps, and is applied by means of a bent platinum wire maintained at a white heat.

Arsenious acid* has long been used in connection with acetate of

* The employment of arsenious acid for the destruction of an exposed dental pulp and the relief of the pain arising therefrom originated with the late Dr. Spooner, of Montreal; and in 1835 it was recommended to the profession by his brother, Dr. S. Spooner, of New York, in an excellent popular treatise upon the teeth.

morphin and creasote, or carbolic acid, to devitalize the pulp; the arsenic and morphin being mixed in equal parts and taken up on a small pellet of cotton saturated with creasote, which is introduced directly upon the exposed portion of the pulp, and the cavity filled with wax or cotton saturated with a solution of gum sandarach and alcohol. The morphin was formerly supposed to modify the irritating action of the arsenious acid; but since this has been discovered not to be the case, its use has been dispensed with by many who prefer no other combination than creasote or carbolic acid. Water, alcohol, and ether have also been employed as substitutes for the creasote. The arsenious acid is at times combined with an equal part by weight of pulverized charcoal, on account of the antiseptic properties of this latter agent and also on account of its mechanical action in preventing the dentine from absorbing what is intended for the pulp alone. A favorite mixture is known as "nerve paste;" but when a definite quantity of the arsenious acid is desired for application to a pulp it is better to employ the dry form. Various formulæ are in use for the preparation of devitalizing mixtures, such as equal parts by weight of arsenious acid and acetate of morphin; three parts by weight of arsenious acid to two parts of morphin; two parts of arsenious acid and one part of morphin. Creasote or carbolic acid is generally employed to combine the ingredients and also to act as a sedative. Although the thirtieth part of a grain of arsenious acid is the average quantity generally employed to devitalize the pulp, yet the amount may be reduced to the $\frac{1}{100}$ of a grain in many cases when judiciously used. The length of time the preparation should be allowed to remain varies from six to twenty-four hours. Dr. J. F. Flagg recommends the following formula:—

R.	Arsenious acid,	gr. j.
	Acetate of morphin,	gr. ij.
	Carbolic acid,	gtt. iij.

A very convenient form of devitalizing mixture is that known as "nerve fibres," which consists of a combination of arsenic, creasote, tannin, and opium incorporated in the fibres of cotton or lint, which is afterward dried and cut up into shreds. Dr. James Gordon has suggested the following method of devitalizing pulps, which is claimed to be less painful than that heretofore employed: After carefully cleansing the cavity saturate a very small pledget of cotton, held by a foil carrier, with benzol, and then apply to the cotton a little nerve paste, and place the whole directly upon the exposed pulp and cover it by loosely filling the cavity with cotton saturated with sandarach varnish. If a solution of caoutchouc in benzol is employed to satu-

rate the first pledget of cotton to which the nerve paste is applied, the preparation will better retain its place in the cavity and is less liable to be displaced when the retaining pledget of cotton saturated with sandarach is introduced.

When arsenious acid is applied to temporary teeth the quantity employed should be very minute, and many are disposed to question the safety of its application to such teeth, as the agent may be absorbed by the very vascular structure and injure the surrounding membranes. Not unfrequently cases are met with where repeated applications of the preparation fail to destroy the vitality of the pulp, which is doubtless owing, in cases where the organ is fairly exposed, to its inflamed condition at the time the application is made, which enables it to resist the absorbent action of the arsenic. In such cases a preparation composed of tannin and creasote has proved serviceable.

Arsenic when applied to a pulp excites inflammation, and as this condition passes off the agent is absorbed and devitalization follows. Too great a quantity of arsenic will defeat the object, and in many cases its devitalizing action is prevented by the high degree of inflammation present, so that it is necessary to reduce the inflammatory condition before a successful application of the devitalizing agent can be made.

The time the arsenious acid is permitted to remain in the tooth is important, and should be determined by the condition of the pulp, the class of tooth, the structure of the tooth, the age of the patient, and the susceptibility to the influence of the agent. The time necessary for the action of arsenious acid varies from six to twelve and in some cases twenty-four hours, when minute quantities are employed.

As the degree of inflammation excited by the arsenic depends upon the quantity of the agent employed, it is much the safer and better plan to apply small quantities than an amount which will devitalize the pulp by one application; for in the latter case there is danger of the effects being carried to the peridental membrane through the apical foramen.

It is often very difficult to retain the devitalizing agent on fractured teeth when it becomes necessary to destroy their pulps. A method pursued by some is to apply a minute quantity and cover it with gutta-percha, which is held in position by ligatures. Another method suggested by Dr. Rich is to secure the arsenical preparation by surgeon's rubber plaster, passing it around any portion of the crown which remains.

Dr. E. C. Kirk, whose experiments with coagulants in pulp-canals demonstrate very clearly that notwithstanding the care we may take in sealing drugs in the cavity of a tooth, we cannot prevent their exerting

destroy pulps ; the method being first to apply the carbolic acid to the exposed surface of the pulp, and then the nitric acid on a small disc of card-board cut a little larger than the orifice of exposure and retained for half a minute. After this is removed a second application of the carbolic acid is made, and the pulp removed from the cavity by means of a barbed broach. Some employ a fine splinter of wood dipped in nitric acid, which is thrust into the previously obtunded pulp. Repeated applications of carbolic acid, chlorid of zinc, nitrate of silver, or caustic potash are also preferred by some to arsenious acid for devitalizing agents. A piece of hard elastic wood, shaped to conform to the pulp-canal, which is freely opened, and suddenly forced up on the pulp by the blow of a condensing hand-mallet, is recommended as being almost painless.

CHAPTER VII.

SENSITIVENESS OF DENTINE.

WHILE inflammation of the soft tissues exhibits such symptoms as pain, redness, heat, and swelling, the dentine of a tooth in a similar pathological condition does not indicate all such manifestations ; for, owing to its peculiar structure, there is no redness, on account of a want of red globules, nor swelling, on account of the density. There is, however, exalted sensibility, and to such a condition the term inflammation has been applied. Inflammation of the dentine is due to exposure of this structure consequent upon the breaking down of the enamel or protective covering, and its degree will depend upon the organic structure of the teeth, susceptibility to irritation, and the nature of the irritating agents. Teeth that are very vascular and highly organized are often extremely susceptible to the action of irritating substances, and such a state of exalted sensibility may at times be occasioned by disturbance of other and remote organs, such as the uterus, for example.

The direct cause of inflammation of the dentine is irritation of the fibrillæ, which occupy the dentinal tubuli and are processes from the odontoblasts, and proceed through these tubules to the periphery of the dentine, and, in some cases, even beyond this structure. The odontoblasts are arranged in a layer on the outer surface of the pulp, and slight irritation of the ends of the fibrillæ, which proceed from these cells, results in the formation of secondary deposits of dentine.

The greatest sensitiveness is generally found where the union of the dentine with the enamel occurs, for the reason that at this point the fibrillæ on terminating bifurcate on the periphery of the dentine, and are more closely arranged, which accounts for the greater sensitiveness of dental caries in its incipient stage, and also for the increased sensitiveness of the dentine at its periphery.

Dr. Bödecker and others claim to have proved that the fibrillæ and their coarse offshoots are formations of living matter, and that the basic substance, which is so rich in lime salts, is traversed by an extremely delicate filigree of living matter. Dr. Herbst has also shown that only a portion of the pulp tissue left alive in the pulp-canals is capable of preserving the life of the dentine and enamel.

Dr. Bödecker,* in accounting for the transmission of pain through the dentine, says: "Nerves are made up of living matter, and owing to their reticulated or beaded structure, are fittest for that transmission of contractions" (living matter being contractile tissue, according to Heitzman) "from the periphery to the nervous centers which we call sensation. Contraction of the dentinal fibres transmitted into the reticulum of the protoplasm at the periphery of the pulp, and thence into the ultimate nerve fibrillæ,—all of which formations are proven to be continuous,—are sufficient to explain the transmission of sensation—pain."

A tooth is sometimes exceedingly sensitive when the pulp is not exposed; but, in the majority of cases, this need not deter the operator from removing the decayed part and filling the cavity, for the inflammation of the dentine may be confined to a thin lamina directly beneath the carious matter, and the only inconvenience it will occasion the patient will be a little suffering during the operation, and slight momentary pain for a few days, whenever anything hot or cold is taken into the mouth. A sharp, thin instrument rapidly used with skillful touches will often prove effective. But when the sensibility is so great that the patient cannot bear the removal of the diseased part, as occasionally occurs, it may be allayed by the application of chlorid of zinc to the cavity of the tooth for from three to six minutes. When this is done, care should be taken to prevent it from coming in contact with any of the soft parts of the mouth, on account of its active escharotic properties.

For the destruction merely of morbid sensibility in the solid structures of a tooth, chlorid of zinc is one of the oldest agents employed for such a purpose. Although a powerful escharotic, it does not, as all arsenical preparations are liable to do, produce any deleterious effect

* "Anatomy and Pathology of the Teeth."

on the pulp of the tooth. It is thought, however, in some cases to modify the texture of the dentine; and, in the opinion of some practitioners, so much so as to render it more easily acted upon by decaying agencies. When first applied it excites a sensation of heat, followed by burning pain; but these soon subside, and on removing it from the tooth the parts of the cavity with which it was in contact will, in a large majority of the cases, be found totally insensible to the touch of an instrument.

The chlorid may be applied directly to the cavity of a sensitive tooth, without being combined with any other substance, on a little raw cotton or lint; or it may be made into a paste by mixing it with an equal quantity of flour, the moisture which it absorbs from the atmosphere being sufficient for the formation of the paste; or it may be mixed with a little pure anhydrous sulphate of lime in an impalpable powder and then applied to the tooth. But before this is done as much of the decomposed dentine as possible should be removed, and the application should be held firmly in contact with the part of the cavity on which it is intended to act. A single application will generally suffice to destroy the sensibility to a sufficient depth as will enable the operator to remove any remaining portions of decayed dentine without pain; but repeated applications are sometimes necessary.

Tannin or tannic acid in alcoholic solution, or in creasote and glycerin, are valuable applications for this pathological condition of the dentine. Nitrate of silver, chromic acid, and the terchlorid of gold are also used for the same purpose—the nitrate being applied in either a solid form or in a concentrated solution; and while it affects the dentine to a greater depth than either the tannic acid or chlorid of zinc, yet its action is not so painful as the latter.

Creasote and carbolic acid, either alone or combined with acetate of morphin or tannic acid, are extensively used for this condition of dentine, and are among the safest of these agents.

Chloroform applied to the cavity on a small piece of cotton will often give a temporary insensibility, and has the merit of being quite harmless; which cannot be said of chlorid of zinc, arsenic, or cobalt—the first sometimes acting injuriously upon the dentine, the two latter upon the dental pulp.

A mixture of chloroform and aconite, equal parts, is also recommended; also, carvacrol, oil of cloves, oil of cedar, oil of eucalyptus, glycerin and tannin, creasote and tannin, camphor and chloral solution, camphorized ether, oxid of calcium (this latter, however, causes considerable pain when first applied), carbonate of sodium, menthol, thymol, the sesquichlorid of chromium, a mixture of equal parts of tincture of aconite and a saturated solution of iodin, carbonate of

potash, equal parts of sulphate of morphin and gum camphor, ethylate of sodium, carbonate of potash and glycerin, equal parts of crystallized carbolic acid and caustic potash, made by mixing into a crystalline paste and known as the "Robinson Remedy," and the insertion of temporary fillings composed of oxychlorid of zinc or oxyphosphate of zinc, or Hill's stopping.

The desiccation of the sensitive surface by heated air, so far as is possible, is also of great benefit. When this method is employed all moisture is excluded and the air injected by a hot-air syringe, the blast being gentle at first, and applied at intervals of a few seconds, and as the pain diminishes the force is increased at shorter intervals until the pain ceases, when the operation can be proceeded with.

An efficient means for the application of heat as an obtunder of sensitive dentine is the "Dento-Electric Cautery," represented in Fig. 130. The looped-wire of this instrument is rapidly passed across the sensitive surface, and obtunds it to such a degree as to produce an immunity from suffering of considerable duration.

In the instrument a platinum loop, A, is held by set-screws, B, in contact with metal conductors which pass through a hard-rubber handle. The battery wires are coupled to the two terminals, C. The appliance is held in the hand somewhat in the same manner as a pen or pencil in writing, and the circuit is closed by pressing upon the spring, D, with the forefinger, when the resistance of the loop causes it to become heated. The platinum loop when destroyed is readily and inexpensively replaced.

A safe way of meeting the difficulty in slight cases is to have the excavators and burs very sharp and well tempered, and to cut firmly and decidedly (for the scraping of a dull instrument is quite as painful as the cut of a sharp one), making cuts "which sweep the circumference of the cavity," or in a direction from the pulp chamber.

Friction, by means of a burnisher, is also recommended as being effectual where the position of the sensitive surface will permit of its use.



FIG. 130.

When painful escharotics are employed, the sensitive-ness of the dentinal surface should first be obtunded by the application of a solution of sulphate of atropin, or other local anesthetic.

When local obtunders are inefficient, or from the nature of the case

cannot be applied, the inhalation of sulphuric ether has been resorted to with beneficial results.

Having noticed the agents usually employed for destroying morbid or hyper-sensibility in dentine, we will proceed to notice a few of the non-conductors against thermal influences that have been used for the accomplishment of the same object. Among the substances which have been employed for this purpose are *asbestos*, *gutta percha*, *cork*, *oiled silk*; also such filling materials as *Hill's stopping*, chloro-percha, the *oxychlorid* and *oxyphosphate* of zinc.

Asbestos, as a non-conductor of caloric, certainly possesses every desirable property, and is as indestructible in a tooth as gold. When used for this purpose the purest variety should be selected. A small pellet made from the filaments of this mineral, placed in the bottom of a cavity previously to filling, will effectually prevent irritation of the pulp from impressions of heat and cold. The cavity, however, should be first properly prepared, washed with tepid water, and made perfectly dry. The asbestos may occupy from one-fourth to one-sixth of the depth of the cavity after the filling has been introduced and consolidated.

A thin layer of gutta percha placed in the bottom of the cavity, previously to introducing the gold, is as effectual in preventing the transmission of impressions of heat and cold as asbestos, and can be more conveniently applied. There is, however, a preparation of it, known as "Hill's stopping," which is better than the simple article for a temporary filling.

Cork is an equally good non-conductor of caloric, but some object to its use on account of its being more destructible than asbestos or gutta percha; but cut off, as it necessarily would be in the bottom of the cavity beneath the filling, its liability to undergo any change would seem to be rendered wholly impossible. But it is of a more porous nature than gutta percha, and cannot be adapted as perfectly to the inequalities of the floor of the cavity. There is also danger, in introducing the filling, of forcing some portions of the gold through it, unless a very thick piece be used. Oiled silk has also been used in some cases very successfully, but it is not as good a non-conductor as either of the afore-mentioned agents. Mastic, copal and other varnishes are also used as non-conductors in sensitive cavities prior to the introduction of the metallic filling.

The filling materials known as oxychlorid of zinc and oxyphosphate of zinc often prove effectual in preparing a sensitive cavity for a more durable metallic filling. For the method of applying these agents, and also Hill's stopping, the reader is referred to the chapter on "Materials Employed for Filling Teeth."

Should it, however, be necessary to fill the cavity with a more permanent material, such as metal, and the inflammation is confined to a portion of the dentine, this may be protected by a layer of the non-conducting material and the metal introduced over it.

CHAPTER VIII.

TUMORS OF THE MOUTH AND JAWS.

TUMORS of the gums are of various kinds; some interesting cases of simple hypertrophy are reported by Dr. Gross and Mr. Salter and Mr. Erichsen which are reproduced by Mr. Heath in his admirable "Essay." Mr. Salter's case was found to consist of a pinkish, corrugated, and lobed mass, composed of an expansion of the alveolus, with "immense hypertrophy of the fibrous gum, and an exuberant growth of the papillæ of the mucous membrane." Dr. Gross's case was somewhat similar. Mr. Erichsen's was found, "on section, to consist of firm, fibrous stroma, containing much glandular tissue in its interstices, and covered on its surface by very large and vascular papillæ. The epithelial layer was of unusual thickness, but no abnormal epithelial structures were found in the growth, which was an example of true hypertrophy." (Heath's "Jacksonian Essay," 190.)

A peculiarity of this case was that the teeth were also hypertrophied. In each of these cases the diseased tissue was removed and the exposed surface cauterized.

Polypus is a simple hypertrophy of the interdental gum, or dental pulp, and is generally occasioned by the irritation of a worn-out or broken tooth with a ragged edge. In structure these growths are like the gum from which they arise. They seldom give much pain, except ulceration should take place. If simply cut away they are very likely to return, but if the tooth is removed and astringent or cauterant applications be made they give but little trouble.

Continuous pressure by gutta percha or other means will also control them.

Mr. Salter reports two cases of "Papillary Tumors of the Gums," consisting almost entirely of epithelium, arranged in filiform papillæ resembling those of the tongue. It is described as "a curious white mass, consisting of coarse, detached fibres, pointed and free at one extremity and attached at the other; in fact, it was a mass of papillæ, many of them nearly an inch long, and similar in shape to the 'fili-

form ' papillæ of the tongue ; their surface was shreddy and broken ; among the elongated processes were a few rounded eminences like ' fungiform ' papillæ, and these had a smooth and broken surface.'"

The term *Epulis* is usually applied to tumors springing from the margin of the gums, whatever their structural character. They most commonly spring from the gum between two teeth ; as they continue to grow the base may increase also in size till it covers the alveolar bone, or it may undergo superficial development, the point of attachment undergoing but little change ; in other words, it may possess a broad, flattened base or a narrow pedicle. In structure it bears a close resemblance to the gum, and sometimes has imbedded in it spiculæ of bone, which may have been detached from the alveolar bone, constituting the source of irritation which gave rise to the morbid growth ; or it may have been a true osseous development ; a portion of germinal matter, having escaped from its true osseous relation, has been here arrested, established a false center of growth, and undergone development, in obedience to the primitive impulse of the parent cell from which it was derived.

Fig. 131, from Mr. Heath, is a typical epulis of the most common variety. It is seen to be a "firm fibrous tumor," with "some fibroplastic cells intermingled." This variety of epulis is not unusually attached to the periosteum of the alveolus, with projecting spiculæ of bone entering it from the maxilla.

Left to themselves, these tumors will often continue to grow, encroaching upon the tongue, hard palate, and teeth. They are thus made liable to injury by the teeth, and an ulcerated surface is in this way established, which discharges freely, occasions considerable pain, and may become the seat of hemorrhage.

A softer and more vascular variety is described by Mr. Hutchinson as consisting of fibrous tissue, in which are imbedded a large number of polynucleated cells of the myeloid variety. In the "Transactions of the Pathological Society" he thus describes them: "The epulis presented all the characters of myeloid growth in a most remarkable degree. Its section was very vascular, and showed hues varying from a deep red to buff, and a peculiar light-greenish tint of yellow (xanthoid of Lebert). Scattered in its structures were some detached masses of soft, spongy bone. Under the microscope were seen an abundance of the large polynucleated bodies characteristic of these

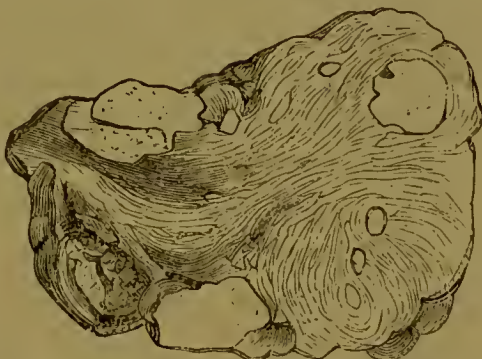


FIG. 131.—(Fig. 90 of "Heath on the Jaws.")

growths, many of them being very irregular in shape and much branched." This form of epulis is most frequently connected with the interior of the alveolus, and hence more closely resembles the endosteal structures. When presenting an ill-conditioned and ulcerated surface, it closely resembles a malignant growth, but does not, as has been thought by some writers, pass into cancer.

Mr. Heath also describes a variety which he calls "giant-celled epulis," consisting of "large, irregular, disc-like cells containing numerous beard-like nuclei interspersed among the fibrous tissue." It presents a surface of uniform smoothness, of a dark-gray color, with numerous purple spots upon it. He considers it as holding a position intermediate between "fibro-cellular and myeloid tumors," and of a similar nature to the growths described by Otto Weber as "giant-celled sarcoma," and as a "fibrous form of cancer arising from bone" by Wedl.

Another form of epulis, resembling epithelioma, and of interest as showing that epithelioma may be developed in the gum as elsewhere, is thus described in a report by Mr. Bruce to Mr. Heath:—

"The surface of the tumor is covered with healthy mucous membrane. The interior of the tumor is whiter, firmer, and more compact than the surface, but there is no line of demarcation between the tumor and its mucous covering. The structure of the growth is distinctly glandular, very much resembling some form of compact adenoid tumor of the breast.

"At the point of attachment of the tumor to the parts beneath a remarkable transformation of the glandular into the epitheliomatous structure is seen. In one part of the section may be seen the cut ends of gland tubules, whilst in their immediate neighborhood are most distinct nests of true epithelioma, consisting evidently of concentrically arranged cells compressed from the center upward."

Mr. Adams reports a similar case which resulted in death, the disease having reappeared in the skin after its removal.

It is often difficult to determine the causation of epulis, but they may often be referred to the irritation of broken or unsound teeth, or to fragments of the alveolar bone which become detached, or to outgrowths from the alveolus; most frequently, however, to roots of decayed teeth; hence, Mr. Heath thinks, the greater frequency of these tumors in women—five to three—they, having a greater dread of all surgical operations, are more likely to permit useless roots to remain in their mouths.

It is rarely fatal, but sometimes attains such size as to produce great deformity, pain, and embarrassment of the functions of mastication and deglutition.

For the treatment of epulis, nothing short of the entire removal of the tumor with its periosteal attachments, together with all decayed teeth, or even sound ones—when the disease seems inclined to reproduce itself—promises any good result. After excision, the actual cautery should be freely applied, for the double purpose of destroying all trace of the disease and of arresting hemorrhage.

Tumors of the hard palate are closely related to epulis, and papillary and epithelial forms are reported—the former presenting but little difference from tumors of the same character arising on the gum.

An epithelial tumor occurring on the hard palate is reported by Dr. Andrew Clark, which was described as “soft, elastic, and vascular. The cut surface is of a dead-white color, distinctly granular, like rough honey, crumbly-looking, and studded with red or pink blotched parts sunk below the general level. On further examination it appears to be permeated by a kind of glairy substance (colloid matter), which helps, seemingly, to give coherence to the tumor. To the naked eye the tumor resembles in some respects a cephaloid or myeloid mass. To the latter it bears the greatest resemblance in general character, seat, and structure. The microscopic characters are those of epithelial cancer, epithelial cells in all stages of development and of the most various forms, together with a few nest-cells and fat. The mucous membrane over the tumor, though not continuous with it, presents the same structural characters. This decides the doubt between the epithelioma and myeloma.” (Heath’s “Jacksonian Essay,” p. 208.)

Encysted tumors of the hard palate are also sometimes found, but they are rare, and require no special description in a work of this character.

These tumors, when epuloid in character, are to be treated in the manner already described. When the bone becomes affected, it also must be removed to such an extent as will leave an entirely healthy surface.

Unerupted teeth may also give rise to osseous tumors, requiring surgical interference. This is more peculiarly the case with the wisdom tooth, for a reason easily understood: the space nominally allotted it, between the second molar and the terminal point of the alveolar ridge, is often too limited for its eruption; endeavoring to make its way through the bone under such circumstances, the opposition it encounters is often sufficient to occasion great irritation and pain, and occasionally to entirely prevent its eruption. The retained tooth thus becomes a center of irritative action, and may serve not only to determine the site, but the fact of such tumors. Mr. Tones also relates a case in which the wisdom tooth was bound down by a “mass

of enamel, dentine, and cementum, thrown together without any definite arrangement," which occupied the place of the second molar. Mr. Heath also records a case, reported by Dr. Forget, in which a tumor about the "consistence of ivory," covered everywhere with enamel, and about the size of an egg, occupied that portion of the jaw between the ramus and the first bicuspid. It was composed chiefly of enamel and dentine, with portions of cementum "dipping into the crevices" here and there, and was regarded by Dr. Forget as a "fusion and hypertrophy of the last two molars."

Again, one of the anatomical elements of the tooth may become so hypertrophied as to constitute a troublesome disease and call for surgical interference. The cementum is most likely to undergo such change. M. Maisonneuve reports a case cited by Mr. Heath, in which the hypertrophied cementum attained the size of a pigeon's egg.

It is desirable, if possible, to remove all such morbid growths without injury to the bone in which they are implanted; but it may become necessary to excise that part of the jaw in which it is. All neighboring teeth which may possibly be associated with it should be removed.

Tumors of the antrum and upper jaw may be appropriately described together, the distinguishing characteristics being pointed out.

Polypus.—Growths of this character occasionally occur in the antrum, and are closely allied to the small cysts occurring in its mucous membrane; both are essentially a "hypertrophy of some element of the mucous or sub-mucous tissue. When the connective or areolar tissue predominates, the fleshy polypus is produced; when the glandular element is especially affected, we have the cystic form produced. Intermediately, when the fibrous element is very loose and we have some glandular hypertrophy, the semi-gelatinous polypus is produced, which closely resembles the nasal polypus." ("Jacksonian Essay," p. 210.)

Antral polyps are very vascular, and are sometimes the ushers of malignant disease. The diagnosis is exceedingly difficult until they have advanced sufficiently to break down the osseous wall somewhere; this most frequently takes place into the nose, through the thin nasal wall.

They should be removed as soon as ascertained to exist, and the troublesome hemorrhage which is likely to occur should be arrested by injections of a reliable styptic, in any strength which is not likely to give rise to trouble, if the opening is sufficiently large to permit its ready escape.

A single instance of a peculiar form of fibroid growth of the antrum

is recorded by Mr. Heath, from whose work we take the following description by Mr. Bruce :—

“It appears to consist of a fine, soft, fibrous stroma, in which very numerous nuclear bodies and a few elongated fibre-cells are distributed. Its structure resembles that of the upper strata of a mucous membrane, from which it is probably an outgrowth. It consists of newly-formed fibrous tissue, and of the elements from which fibrous tissue is developed, and may, therefore, be classed among the simple fibro-plastic growths as distinguished from the true myeloid tumors.”

Fibrous tumors of the upper jaw are not unlike fibrous tumors found elsewhere. They are slow of growth, dense in structure, with interlacing, slender bundles of fibres, and are frequently lobulated. They commonly spring from the interior of the antrum or from the alveolus, and sometimes attain to an enormous size, crushing in the antrum or obliterating its walls by absorption, encroaching upon the orbit, destroying its floor, penetrating the nasal cavity, and, extending outward, conceal the teeth on the same side from view. Mr. Liston removed a tumor of this kind from the face of a lady, where it had arisen six years before, apparently from a blow received on the face, and had attained to an enormous size, covering the whole of that side of the face. Its smallest diameter was six inches. This tumor became of increased vascularity after the cessation of the catamenia at the regular monthly period, and bled slightly at these times from the adjacent parts of the gum. They are usually of an oval or rounded form, freely movable, and painless. When laid open they present a white, shining, ligamentous structure, and are composed of nucleated fibres. If left to themselves they may become softened in the center and undergo disintegration, though Mr. Heath thinks they never suppurate except where they have been punctured in establishing a diagnosis. They may also undergo calcareous degeneration, but are never ossified.

Mr. Paget reports a case in which distinct pulsation, synchronous with the radial pulse, was felt. They rarely recur after removal, perhaps never when entirely removed. Mr. Weber thinks “they are usually connected with the lining of the Haversian canals,” and advises that a portion of the bone be removed in all operations. Their origin is usually referred to the irritation of decayed teeth or to direct violence.

Fibro-cellular tumor, or osteo-sarcoma, is of softer consistence than the simple fibrous tumor; they are smooth, round, elastic tumors, of a yellowish color, and are infiltrated with a serous fluid. Unlike the simple fibrous tumor, they exhibit a strong tendency to ulceration, which sometimes serves to confound them with malignant growths, from which they are to be distinguished by the history of the case and

the non-implication of the lymphatic glands. They are thus described by Sir Philip Crampton: "In the earlier stages of the disease the tumor consists of a dense, elastic substance resembling fibro-cartilaginous structure, but the resemblance is more in color than consistency, for it is not nearly so hard, and is granular rather than fibrous, so that it '*breaks short*.' On cutting into the tumor the edge of the knife grates against spicula, or small grains of earthy matter, with which its substance is beset." Fibro-cellular tumors may undergo fatty or calcareous degeneration.

Recurring fibroid tumors occur, if at all, so rarely in the upper jaw, that any description is unnecessary in a work of this kind. The same may be said of vascular tumors.

Myeloid tumors are described by Mr. Paget as occupying an intermediate position between fibrous and fibro-cellular tumors. They are composed of parallel fibres, with fibro-plastic cells, and bear a close resemblance to "granulation cells in process of development into fibro-cellular tissue." On section they present a smooth, shiny, semi-transparent appearance; are of a pinkish or bluish color and of brittle texture. They usually occur in the young, are painless, and seldom recur. Externally they present a dark maroon color, quite characteristic. An excellent description of a tumor of this class is furnished Mr. Heath by Dr. Tonge, from which we make the following extract: "It was of firm consistence throughout, and on section presented a whitish appearance, with a small pink patch or two, and a whitish, creamy-looking juice could be scraped from the cut surface. . . . The fibrous element was much less abundant than the cellular, and consisted of white fibrous tissue, with numerous fine, curling fibres of yellow elastic tissue, and many small oval and rounded nuclei were imbedded in the fibrous structure. The greater portion of the tumor seemed to be composed of cells. These were mostly of an irregularly rounded form, often with pointed processes; and some shuttle-shaped and spindle-shaped, of a somewhat trapezoidal form, were not uncommon, while a few cells presented the character of those distinctive of myeloid tumors. All the cells contained one, and often two, very large and generally oval nuclei, with one, two, or three nucleoli, and a variable number of oil globules. The myeloid cells observed were of irregular outline and contained from three to five nuclei, with single or double nucleoli; one very large cell contained six nuclei."

Their formation takes place slowly, after the manner of cyst formation or other simple tumors. When the bone has been removed by absorption or otherwise they may be recognized by their characteristic color, and when a cyst forms within them, as sometimes happens,

myeloid cells may be found in the fluid that escapes when it has been punctured, thus distinguishing it from cystic formations.

Cartilaginous tumors are of two kinds: simple, innocent, or benignant tumors, and tumors presenting a malignant appearance. Those of the first class present a round or ovoidal form, are smooth, hard, of slow growth, and painless. Those of the second class grow with great rapidity, to a large size, and are of a malignant appearance.

Cartilaginous tumors occur on the upper jaw, but may affect it secondarily by extension from other parts.

Mr. Heath describes specimens taken from St. George's and St. Bartholomew's Hospitals, in one of which the disease occurred on the inner side of the orbit, and two years later had pressed the superior maxillæ forward nearly an inch beyond the inferior, while the "bones of the face and orbit were extensively absorbed." In the other the superior maxillary bones were entirely absorbed, the cavity of the skull was invaded, and the brain pressed aside; it is attached to the soft palate below, and presses forward the walls of the nose in front. Mr. Paget relates a case in which the disease had existed nine years, was removed, but returned, and the patient died seven years after. "A section of the tumor showed that it was composed of an outer, hard, thin shell of bone, completely enclosing a morbid growth of spongy, cancellated structure, devoid of all appearance of carcinomatous or spongy disease." These growths are usually very slow, and when removed exhibit but a slight tendency to recur. Cases are reported in which the free local use of iodine has effected the absorption of tumors of this kind that had not yet attained a large size. They sometimes soften, disintegrate, slough, and establish fistulous openings, through which a jelly-like mass escapes.

Osseous tumors in their simplest form are but a hypertrophy of previously existing bone tissue. They are predisposed to by syphilitic and scrofulous affections, and sometimes their immediate origin may be traced to the irritation of imperfect teeth; in general, however, it is difficult to refer them to a determinate cause. They are of slow growth, painless, and closely resemble true bone in structure. Their slowness of growth, hardness, painlessness, and fixity are the characteristics on which a diagnosis may be based, though they are occasionally movable. Occasionally they ulcerate, and troublesome fistulous openings are established. When of a large size they may invade important organs, occasioning great trouble, as in the case reported by Mr. Hilton, where it invaded the orbit and by its pressure burst the ball of the eye.

Cancerous tumors of the upper jaw are, in Mr. Heath's experience, limited to the medullary form; other observers have, however, occa-

sionally met with schirrhus. Mr. Hancock advanced the view that medullary disease does not begin in the antrum, but in the bones at the base of the skull. This view is refuted by the observation of Mr. Liston and others, who have shown that it unquestionably begins in the antrum very often. They are characterized by rapid development, softness to the touch, and, when fully established, by a peculiar expression and sallow, putty-like appearance of the skin. In this situation it is seldom accompanied by glandular enlargement. By pressing upon the nasal duct it may occasion considerable edema of the lower eyelid, with enlargement of the facial veins, from obstructed circulation.

For the cure of all solid tumors of the upper jaw there is but one remedy on which we can rely—the knife. All operative procedures should be resorted to at the earliest practicable moment, before the facial structures have been extensively invaded by the disease. When the disease is entirely removed, in even malignant growths, we may sometimes entertain a hope of permanent relief. To effect the removal of tumors in this situation various methods have been devised. Until 1826 surgeons usually contented themselves with the removal of so much of the disease as could be effected with the gouge and chisel; but about this time Mr. Lizars, of Edinburgh, proposed the removal of the entire superior maxilla, having previously secured the carotid artery. An opportunity to carry out his suggestion did not offer until December of the following year, when, in attempting this operation, the hemorrhage, notwithstanding the ligation of the carotid, was so great as to necessitate the discontinuance of the operation. In the meantime, without any knowledge of Mr. Lizars' suggestion, Mr. Gensoul successfully removed the upper jaw without securing the artery and with but little hemorrhage. Mr. Lizars afterward operated successfully, and the operation is now an established one. His incision was carried from the angle of the mouth to the malar bone, where, when more space was required, it was met by a short, vertical incision, and an incision was also made from the middle line of the lip to the nostril. Mr. Gensoul employed a vertical incision from the inner canthus to the angle of the mouth, which was met midway by another at right angles to it, letting fall on its outer extremity another vertical incision. The bone was then removed with the mallet and chisel. An obvious objection to these operations was the great deformity occasioned and the division of the facial nerve. To obviate these difficulties Sir William Fergusson suggested a plan, which has since been very generally adopted. It consisted solely in an incision from the middle line of the lip to the nostril, when, by stretching the integument, sufficient space was usually gained. If more, however,

was required, the incision was carried up alongside of the nose to the inner canthus, and below the eye to the outer canthus; thus the facial nerve and artery were divided so high up as to give but little trouble, while the scars are most favorably situated (see Fig. 132).

After deflecting the skin, a small saw is passed into the nostril, with which the hard palate and alveolus are divided. The nasal and malar processes of the superior maxilla are next sawed nearly through, and the division completed with bone forceps. The bone is then grasped by the powerful forceps devised by Sir William Fergusson, and forcibly wrenched from its attachments to the pterygoid process and palate bones. The infra-orbital nerve is then divided, the soft palate carefully dissected from the detached bone, which is ready for removal, after which hemorrhage is arrested by ligatures and the actual cautery, and the wound closed with silver sutures. When



FIG. 132.

the palate bone and orbital palate are not involved they may be spared by sawing horizontally above and below them respectively. Sir William Fergusson now prefers to avoid the removal of all healthy tissue by attacking the disease from center to circumference with strong curved and angular bone forceps. Both superior maxillæ have occasionally been removed; but it is an operation so seldom required that a description of it is not called for in a work of this kind.

Tumors of the lower jaw do not differ in essential particulars from those already described. They are more readily diagnosed and safely removed than those of the upper jaw. Deaths are comparatively rare from operative procedures here. When the tumors are small they may be removed without incision of the lip by simply dissecting them from their attachment to the bone, turning them down, and removing the diseased portion with bone forceps. When a large body is to be removed the incision should be carried beneath the margin of the jaw, where the scar shall afterward be concealed from view. When the bone is exposed we should endeavor carefully to ascertain if the disease may

not be removed with the external plate of bone alone ; if this may not be done, the saw should be brought into requisition and the diseased structure removed. Amputation of the lower jaw is far more readily effected than of the upper. For a detailed account of this operation the student is referred to more exclusively surgical works.

CYSTIC TUMORS, DENTIGEROUS CYSTS.

It must be remembered, in connection with diseases of the antrum, that it is of variable size, with walls of variable thickness. In youth the walls are thick and the cavity small. After attaining its maximum size in the adult it is found again to diminish with old age ; it is larger in males than in females. But in adult life its capacity varies in different subjects, from one dram to eight drams, the average capacity being about two and a half drams.

Suppurative inflammation, or abscess of the antrum, is commonly due to extension of inflammation from the teeth to the lining membrane of its cavity. The roots of the first and second molars not infrequently present prominences at the antrum, and sometimes the first molar roots are found extending into this cavity entirely uncovered by bone. It will, therefore, be readily seen how disease of the roots may prove a source of irritation and inflammation to the lining membrane of this cavity ; but such direct communication is not necessary ; and disease beginning in alveoli not in immediate relation with the antrum may extend through intervening bone and establish communication. Direct blows upon the face may also induce suppurative inflammation of its membrane, and it may also arise from "pressure during birth."

The symptoms are, pain of a dull character, shooting up the side of the face and head, rigors succeeded by irritative fever, with tenderness and swelling of the cheek. As the pus accumulates, the pressure to which it subjects the walls of the cavity, together with the vitiated nutrition occasioned by its presence, determines absorption of the bone and the discharge of the contained fluid through the opening thus established either into the orbit or by the side of the teeth. Before an opening is established, however, the orbital wall may become so dilated as to occasion partial blindness by displacement of the eye, or it may even induce an amaurosis which shall result in permanent blindness. Sometimes extensive necrosis is occasioned, affecting all the adjacent bones, as in the case reported by Mr. Salter, in which the "floor of the orbit, the upper cheek portion of the superior maxilla, and the infraorbital, and a large plate of bone from the inner (nasal) wall of the antrum, were involved." Dr. Mair, of Madras, reports a case in which death resulted in sixteen days, though apparently begin-

ning as a simple ozena. The post-mortem examination in this case revealed a condition of things that led Dr. Mair to conclude that it began as a "disease of the antrum, originating in degeneration of the mucous membrane lining its cavity, or, perhaps, connected with the soft tumors which grow from the apex of the tooth and from the lining membrane of the root; secondarily, involving the ethmoid, lachrymal, palatine, and inferior turbinated bones of the left side, causing suppuration and disintegration, the purulent matter filling the cavity of the antrum extending toward the left nostril, causing ozena, and upward into the orbit, behind the globe of the eye, pushing the eye outward and forward, the matter finding its way through the optic foramen to the anterior surface of the left hemisphere of the brain, there acting as a foreign body, exciting inflammatory action, terminating in cerebral abscess, causing convulsions, coma, and death." (*Edinburgh Medical Journal*, May, 1806.) Cases of such severity are, fortunately, rare; but they indicate the possibilities of the apparently most simple cases, as well as the line of treatment most likely to obviate such conditions and result.

Treatment.—In the simplest cases in which suppuration of the antrum is strongly suspected, we should at once remove all decayed teeth or roots, and even sound teeth, when found to be tender. If matter has not yet formed, the disease may then subside under the use of simple fomentations. It is safer, however, in most cases, to penetrate the antrum, preferably through the socket of the first molar, because of the greater depth of the socket; and this, too, without delay, care being taken to regulate the force so as not, by too great violence, to injure the floor of the orbit. Should the teeth be sound and it be desired to save them, an opening may be made through the alveolus above the gum. The cavity should be freely injected with tepid water, and subsequently with some slightly stimulating and antiseptic lotion; and care must afterward be taken to prevent the admission of foreign substances into the cavity.

In the more chronic forms of this disease the purulent accumulation takes place so slowly, and the consequent expansion is so gradual, that it is often mistaken for solid growths; and in many cases the diagnosis is of extreme difficulty; surgeons of distinction, having begun an operation for the removal of a solid growth, have been surprised to find their hands bathed in pus, whilst the supposed tumor disappeared from beneath them. In all cases in which the diagnosis is not perfectly clear an exploratory puncture should be made, and thus the difficulty is at once resolved.

Sometimes the pus is enclosed in a second bony investment, due to the ossification of the antral periosteum. When this occurs, it

occasionally happens that the bone remains thickened long after the evacuation of the pus and the entire cure of the abscess, the deformity, of course, remaining unaltered. It then becomes necessary to open the antrum and remove this ossified periosteum.

A clear or yellowish serous fluid is not unfrequently found in the antrum, which the older writers took to be a secretion of mucus, which, having failed to make its escape by the aperture between the antrum and the nostril, accumulated in such quantity as to occasion wasting of antral walls to such an extent as to permit the fluctuating mass to be felt at certain points. This fluid was found on examination to contain numerous flakes of cholesterin, as is the case in well-defined cystic growths, and, as it in no respect resembled mucus, recent writers have referred this form of disease to cystic formations.

The most recent and able writer on this subject, Mr. Heath, thus describes their mode of origin: "It is certain, however, that some of these cases, and very probably all of them, originate in the growth of a cyst, or cysts, within the antrum or in connection with the fangs of the teeth, which either grow to such a size as to be mistaken for the cavity of the antrum when opened, or break into the antrum by absorption of the cyst-wall, so that on subsequent examination no evidence of the cyst formation can be discovered."

These cyst formations are also occasionally mistaken for solid growths, and Mr. Heath relates an instance in which "a very able surgeon removed the upper jaw before the mistake was discovered." And Sir William Fergusson relates a case in which a similar error was avoided by an exploratory puncture, which should in no case be omitted.

They may be single or multiple; sometimes there appears to be a "cystic regeneration of the entire mucous membrane." Mr. Giralès, who was the first writer on this subject, thinks they are due to "dilation of the glandular follicles of the mucous membrane, and that in such cases it will be necessary to open the antrum, so as to remove the entire mass, it being useless in such cases to pursue the customary plan of tapping the antrum."

Cysts of teeth are divided by Mr. Heath into two classes: "First, cysts connected with the roots of fully developed teeth; and, secondly, cysts connected with imperfectly developed teeth—to which the term 'Dentigerous Cysts' has been applied in modern times." They occur indifferently in either jaw; in the upper, however, are sometimes complicated with collections of fluid in the antrum, which they have secondarily affected. When of very small size they give but little trouble, and are frequently found attached to the roots of teeth after extraction, where their existence had not before been suspected. They seem to occur most frequently in connection with the incisor teeth, and

sometimes attain a very large size, even when not communicating with the antrum. They are commonly associated with the disease of the root about which they are formed, whether as cause or effect it is difficult to determine, the majority of observers holding the latter opinion. Mr. Paget relates a case in which the cyst contained as much as an ounce of fluid, and was received in a deep depression in the alveolar border of the jaw. And Delpech reports one containing so much as three ounces, without connection with the antrum. They consist essentially of a serous bag growing from the dental periosteum at the extremity of the root, filled with a clear



FIG. 133.—CYSTS CONNECTED WITH ROOTS OF TEETH.

or yellowish fluid with bright shining particles of cholesterin floating about in it. According to Mr. Tomes the morbid process is probably identical with that resulting in the formation of alveolar abscess, but, being less acute, a serous cyst is formed instead of a suppurating one.

Mr. Heath remarks that “large cysts produce more or less absorption of the outer wall of the maxilla, and are very common consequences of diseased teeth, but seem to give surprisingly little inconvenience to the patients, even when of large size and producing considerable deformity of the face. They are commonly confounded with cystic distention of the antrum.”

Mr. Heath says “the clinical history of cysts connected with the teeth is that of painless expansion of the alveolus, more frequently of the upper jaw, with crackling of the bone on pressure and ultimate absorption of the bony wall. The cyst then presents a bluish appearance through the distended mucous membrane, and if large, gives distinct evidence of fluctuation.” When an incision is made into the cyst a dark-colored, clear fluid escapes, but when inflammation is present the contents become purulent.

The treatment of such cysts consists in cutting away the thin outer wall, so that the cavity may granulate up.

Dentigerous cysts occur in connection with teeth, most commonly permanent teeth, in which the process of evolution has been arrested, and is due, Mr. Tomes thinks, to the accumulation of fluid between the enamel and soft outer tissue at the time when the enamel is completed, which fluid is usually discharged when the tooth is erupted; but when the tooth remains within the jaw this discharge cannot take

place, and it continues to increase in quantity until a cyst is established. We are thus enabled to account for the presence of cysts in those cases in which neither the tooth nor adjacent bone presents any appearance of disease. In illustration of this theory, Mr. Tomes relates a case in which, "instead of having the two fangs common to second molars of the lower jaw, the implanted portion of the tooth was dilated into one large concavity, in which was placed the crown of a second tooth, perfectly invested with well-developed enamel, and with the masticating surface directed toward the jaw. The two teeth appear to be united by dentine at one point, and to have one common pulp-cavity. . . . I consider that in the case cited fluid collected between the enamel of the inverted tooth and the remains of the



FIG. 134.—DENTIGEROUS CYST OF LOWER JAW. *b*. Showing position of tooth.

enamel organ, situated within the socket of the second molar. As the cyst enlarged, the contiguous bone was absorbed to make room for it, and new tissue was concurrently developed on the outer walls of the socket till at last a large cup of bone was formed." ("Dental Surgery.")

When cysts of this kind occur in the lower jaw they present more obvious deformity. Sometimes the cyst undergoes calcification, and is exceedingly difficult to diagnose from a solid tumor.

Mr. Heath remarks that "the diagnosis of dentigerous cysts from other cysts is exceedingly difficult until they are opened, as, indeed, is the recognition of any form of cyst. A careful examination of the mouth may reveal the absence of a permanent tooth, or may show a temporary tooth occupying a permanent position. On the other hand,

however, it must be remembered that teeth may be wanting without being connected with any disease."

Many errors of diagnosis, leading to operations for the removal of supposed tumors, have been made by able and distinguished surgeons, who have had the courage and candor to confess their mistakes, among whom may be mentioned Gensoul, Syme, Feavu, and Lisfranc. The two latter gentlemen each removed half the jaw. It is only when the osseous walls have become so wasted as to give under pressure a parchment-like crackling that the diagnosis may be made with any approach to certainty. In every case an exploratory puncture should be insisted on before proceeding to operate. The existence of a cyst determined, and communication with the antrum suspected, the first molar tooth should be removed and the wall of the antrum be perforated through the socket, and if a supernumerary tooth is found in the cavity it should, of course, be removed. In many cases it is necessary to remove the front wall of the antrum and stuff the cavity with lint, thus inducing granulations, before a cure



FIG. 135.—INVERTED CROWNS OF TEETH BETWEEN EXPANDED ROOTS OF OTHER TEETH, CAUSING DENTIGEROUS CYSTS.

can be effected. This can generally be effected without incision of the integument. When feasible, the plate of bone removed should be left attached to the periosteum and be replaced after removal of the cyst.

Cysts in the lower jaw present some peculiarities which make a second description necessary. They may occur in connection with fully developed teeth, or without any direct connection with the teeth. They may be multilocular, and in rare instances may contain one within another. Mr. Coote reports a case in an infant of six months—which resulted in death from exhaustion occasioned by continued discharge after an operation—in which, covered by a thin shell of bone, a perfect nest of cysts connected with the antrum have been shown to arise in the glandular structure of its lining membrane, but in the lower jaw we have no such membrane. Instead thereof we have two layers of laminated bone enclosing a cancellated structure lined by the endosteum alone. Mr. Heath is of opinion that it is in these calculi the disease is developed, "A cancellus expanding and producing gradual absorption and obliteration of its neighbors

until a cyst of considerable size is produced." The causation of cystic formations in the lower jaw is very obscure, though they are probably associated in some way with the irritation from adjacent roots. They may continue to reproduce themselves from time to time, until the cancellated tissue is entirely destroyed.

Cysts in connection with undeveloped teeth—dentigerous cysts—which are common to both jaws, may suppurate and form abscesses. They generally occur, in the case of unerupted teeth, from some irritation, and are more common to permanent than to deciduous teeth. Inversion of the tooth also appears to be a cause of these cysts.

Mr. Heath remarks that "when dentigerous cysts occur in the lower jaw they form more isolated and prominent tumors than in the case of the upper jaw, and in some cases the projecting bony wall has been removed."



FIG. 136.



FIG. 137.

DENTIGEROUS CYST DUE TO NON-DEVELOPMENT OF CANINE TOOTH.

The treatment of dentigerous cysts consists in a free incision and the removal of the unerupted tooth, as a simple puncture will not answer. The front wall of the cyst should be removed, and the cavity filled with lint, "so as to induce granulation and gradual obliteration." This may be accomplished in the majority of cases without any incision of the integuments. After the removal of a portion of the cyst wall, in the case of dentigerous cysts of the lower jaw, the plates should be pressed together as much as possible; and the same may be accomplished in the case of the upper jaw by the pressure of pads and bandages. Mr. Heath directs that the cyst should always be reached by dividing the mucous membrane within the mouth, and without incising the cheek; but, if necessary, a single line of incision only should be made, so that as little after-deformity as possible may be produced.

Unilocular cysts are to be treated simply by extracting adjacent teeth, and, after evacuating the contents, when the walls are thin, crushing them in so as to diminish the size of the cavity. According to Mr. Eve multilocular cysts, so far from having a dental origin, are produced by an ingrowth of the epithelium of the gum. They may result from injury, the irritation of decayed teeth, or long-continued inflammation. They are of slow growth, and present very little tendency to implicate surrounding parts. Multilocular cysts are found in the lower jaw, consisting of cells varying in size from that of a pea to others occupying the entire thickness of the bone.

Multilocular cysts may be treated according to the plan of Mr. Butcher, which consists in dividing the mucous membrane over the cyst freely, and then with a gouge and the bone-forceps removing the expanded external plate of the bone, with the contents and lining membrane of the cyst, interfering with the teeth as little as possible and avoiding the facial artery. Dr. Mason Warren recommends a more conservative practice than that of Mr. Butcher. His treatment consists in the puncture of the sac within the mouth, and at the same time obliterating its cavity by crushing ; then to keep up, by injections, etc., a sufficient degree of irritation to favor the deposition of new bone.

CHAPTER IX.

CALCIC DEPOSITS ON THE TEETH.

SALIVARY CALCULUS.

THE color, consistence, and quantity of salivary calculus, or tartar, as it is most commonly called, vary in different temperaments, and upon all of them the state of the general health exercises considerable influence. The characteristics of this substance, therefore, furnish diagnoses important both to the physician and dentist. Their indications are, in many cases, less equivocal than the appearances of any other part of the mouth ; but, like those of the gums, should not, perhaps, be alone relied upon. It is necessary to interrogate every part from which information can be derived concerning the pathological condition of the several organs of the body.

Salivary calculus is composed of earthy salts and animal matter. Phosphate of lime and fibrin, or cartilage, are its principal ingredients ; a small quantity of animal fat, however, enters into its composition, and the relative proportions of its constituents vary accordingly

as it is hard or soft, or as the temperament of the individual from whose mouth it is taken is favorable or unfavorable to health. Hence it is that the analyses that have been made of it by different chemists differ. No two give the same result.

The black, dry calculus deposited around the necks of the teeth of such only as have good constitutions is never in large quantities; it is dissolved in muriatic acid with difficulty, while the dry, light-brown calculus found upon the teeth of bilious persons dissolves more readily in it; but the soft, white calculus found upon the teeth of individuals of neuro-lymphatic temperaments is scarcely at all soluble in the acids, but is readily dissolved in the alkalies.

All persons are subject to deposits of salivary calculus, but not alike; it collects on the teeth of some in larger quantities than on those of others, and its chemical and physical characteristics are exceedingly variable. It is sometimes almost wholly composed of calcareous ingredients; at other times these constitute but about one-half, or little more than one-half, of its substance, the remainder being made up of animal matter. Nor is its color more uniform. Sometimes it is black, at other times it is of a dark, pale, or yellowish brown, and in some instances it is nearly white. It also differs in density. In the mouths of some it has a solidity of texture nearly equal to that of the teeth themselves; in others it is so soft that it can be scraped from the teeth with the thumb- or finger-nail. The black kind is the hardest, the white the softest, and its density is increased or diminished as it approaches the one or the other of these colors.

Salivary calculus collects in very small quantities on the teeth of persons possessed of the most perfect constitutions, and even on these it is seldom found except on the inner surfaces of the lower incisors next the gums. It is then black, or of a dark brown, very dry, and almost as hard as the teeth, to which it adheres with great tenacity.

It rarely happens that any unpleasant effects are produced by the presence of this form of calculus upon the teeth. The general health is never affected by it, and the only local injury that results from it is slight turgidity of the edge of the gums in immediate contact with it.

The indications, therefore, of this description of calculus are favorable, both with regard to the teeth, gums, and organism generally. The teeth upon which it is found are of an excellent quality and rarely affected by caries. They have the characteristics represented as belonging to the best kind, and teeth of this description are only found among persons having good innate constitutions.

There is another form of black calculus differing from this in many particulars. It is found in the mouths of those having good constitutions, but whose physical powers have been enervated by privation or

disease, or intemperance and debauchery, and most frequently by the last named. It is found in large quantities on the teeth opposite the mouths of the salivary ducts; it is exceedingly hard, and agglutinated so firmly to the organs that it is removed with great difficulty; it is very black, has a rough and uneven surface, and is covered with a glairy, viscid, and almost insufferably offensive mucus.

The presence of this kind of salivary calculus is attended with very hurtful consequences, not only to the gums, alveolar processes, and teeth, but also to the general health. It causes the gums to inflame, swell, suppurate, and recede from the teeth, the alveoli to waste, and the teeth to loosen and frequently to drop out. The secretions of the mouth are also vitiated by it and rendered unfit to be taken into the stomach. Hence, as long as it is permitted to remain on the teeth, neither the skill of the physician nor the best regulated regimen, though they may afford partial and temporary relief, will fully restore to the system its healthy functions.

As this form of calculus is seldom if ever met with except in constitutions fairly excellent, the teeth on which it is deposited are generally sound, but they are often caused, by the disease which is produced in the gums and alveoli, to loosen and drop out.

The dark-brown calculus is not so hard as either of the descriptions of black. It sometimes collects in tolerably large quantities on the lower front teeth and on the first and second superior molars; it is also often found on all the teeth, though not in as great abundance as on these. It does not adhere with as much tenacity as either of the preceding kinds, and can be more easily detached from them. It exhales a more fetid odor than the first variety, but is less offensive than the second.

The persons most subject to this kind of calculus are of mixed temperaments, the sanguineous, however, always predominating. They may be denominated sanguineo-serous and bilious. Their physical organization, though not the strongest and most perfect, may, nevertheless, be considered very good. But, being more susceptible to morbid impressions, their general health is less uniform and more liable to impairment than those possessed of the most perfect constitutions.

The effects arising from the accumulations of this description of salivary calculus, both local and constitutional, are less hurtful than the variety last noticed; but, like that, it causes the gums to inflame, swell, suppurate, and to retire from and expose the necks of the teeth, the alveoli to waste, the teeth to loosen and sometimes to drop out. It also gives rise to a vitiated condition of the fluids of the mouth.

Salivary calculus of a light or pale yellowish-brown color is of a much softer consistence than the darker varieties, and is seldom found

upon the teeth, except of persons of bilious temperament, or those in whom this predominates. It has a rough and, for the most part, a dry surface; it is found in large quantities opposite the mouths of the salivary ducts, and sometimes every tooth in the mouth is completely imbedded in it. It contains less of the earthy salts and more of the animal matter than any of the foregoing descriptions, and, from the quantity of vitiated mucus in and adhering to it, has an exceedingly offensive smell. It is sometimes, though not always, so soft that it may be crumbled between the thumb and finger.

Inflammation, turgescence, and suppuration of the gums, inflammation of the alveolo-dental periosteum, the destruction of the sockets and loss of the teeth, and an altered condition of the fluids of the mouth are among the local effects produced by the long-continued presence of large collections of this variety of tartar. The constitutional effects are not much less pernicious. Indigestion and general derangement of all the assimilative functions are among the most common. When the deposit is not large, inflammation and sponginess of such parts of the gums as are in immediate contact with it, and fetid breath, are the principal of the unpleasant effects produced by it.

White calculus rarely collects in very large quantities, and though most abundant on the outer surfaces of the first and second superior molars and the inner surfaces of the lower incisors, it is nevertheless frequently found on all the teeth. Its calcareous ingredients are less abundant than those of any of the preceding descriptions. Fibrin, animal fat, and mucus constitute by far the larger portion of its substance. It is very soft, seldom exceeding in consistence common cheese-curd, to which in appearance it bears considerable resemblance. Although it exerts but little mechanical irritation upon the gums, it keeps up a constant morbid action in them. Its effects, however, upon the teeth are far more deleterious than any other description of calculus. It causes rapid decay of the organs, and the fluids of the mouth are also vitiated by it.

It is only upon the teeth of persons of mucous habit, or those who have suffered from diseases of the mucous membranes, or those in whom these tissues have been more or less involved, that this kind of calculus accumulates.

Salivary calculus sometimes accumulates in very large quantities, giving to the mouth a most disagreeable and repulsive aspect, and imparting to the breath, not unfrequently, an almost insufferably offensive odor. Fig. 138 represents a set of teeth incrustated with it, and Fig. 139 a single tooth, presented to the author by Dr. W. Allen, of Massachusetts, with the largest accumulation of this substance he has ever seen in one mass. Its longest diameter is an inch and an eighth,

its shortest seven-eighths, and its thickest five-eighths of an inch. Imbedded in its substance is the entire crown and neck of a lower dens sapientiæ, which was removed with it. It is of a light-brown color, and weighs two drams and seventeen grains.

The late Prof. Austen described an interesting case where every tooth, above and below, had been loosened by alveolar absorption caused by this deposit ; no tooth having more than an eighth of an inch depth of socket, and some of them held only by an exceedingly tough attachment to the gum and periosteum. The calculus upon the lower incisors was equal to five times the size of the teeth, most of it being on the inside, and three-quarters of an inch thick at the base.

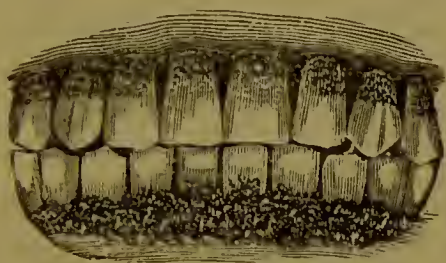


FIG. 138.



FIG. 139.

A singular peculiarity in this case was the excessive pain of extraction. Small as was the attachment, it was uncommonly firm, and the patient, a working-man, was laid up with nervous prostration for two weeks after the operation.

CHEMICAL CONSTITUENTS OF SALIVARY CALCULUS.

Salivary calculus is composed of phosphate of lime and animal matter, combined in various proportions, accordingly as it is hard or soft ; consequently no two analyses will yield the same result.

Schehevetskey gives the following analysis. He found one hundred parts to contain :—

Water and organic matter,	22.07
Magnesium phosphate,	1.07
Calcium phosphate,	67.18
Calcium carbonate,	8.13
Calcium fluorid,	1.55
	<hr/>
	100.00

Dr. Stevenson furnishes the following :—

	<i>Friable soft calculus from molars.</i>	<i>Hard calculus from lower incisors.</i>
Water and organic matter,	21.48	17.51
Phosphate of magnesia,	1.31	1.31
Phosphate of calcium, with a little carbonate and a trace of fluorid,	77.21	81.18
	<hr/>	<hr/>
	100.00	100.00

Hard, dry salivary calculus contains more earthy and less animal matter than the soft, humid calculus.

Chemical analysis reveals a large proportion of mucus, as is shown by the following table of Vaquelin and Langier :—

Phosphate of lime and a little magnesia,	66
Carbonate of lime,	9
Salivary mucus (including ptyalin),	13
Animal matter soluble in hydrochloric acid,	5
Water and loss,	7
	100

An analysis of saliva reveals water, ptyalin, fat, chlorid of sodium, chlorid of potassium, phosphate of lime, and sulphocyanid of potassium.

The infusoria of salivary calculus, according to M. Mandl, have their origin in the vitiated mucus which is always mixed with it.

Scherer detected with a microscope infusoria in large numbers in the saliva of a girl laboring under a scorbutic affection of the mouth ; but the author is inclined to believe that they had their origin in the mucous secretions of this cavity, which are always mixed with the former fluid. They are more or less numerous, as the calculus is hard or soft, or in proportion to the quantity of mucus that enters into its composition.*

ORIGIN AND DEPOSITION OF SALIVARY CALCULUS.

There formerly existed much diversity of opinion as to the source whence salivary calculus is derived, but it is now generally conceded that this deleterious concretion is a deposit chiefly from the saliva, with an admixture of mucus, as the analyses of both these secretions reveal the necessary materials in sufficient quantity to form it. Bidder and Schmidt make the phosphates and carbonates amount to very nearly one per cent. in the saliva. All that is necessary, therefore, is that the surfaces of the teeth should have a sufficient affinity for the substance in question to cause a nucleus, which, when once formed, the secretion continues until serious secondary effects are liable to result.

In most varieties of salivary calculus there is a notable superabundance of the phosphates and carbonates, while in others there is nearly forty per cent. of purely animal matter. Hence the difference in action upon them by acids and alkalis. Of the animal matter entering into the composition of salivary calculus, fibrin, animal fat, and mucus are in the largest proportion.

* Dr. Dwinelle gives a minute description of their appearance in the first number of the fifth volume of the *American Journal of Dental Science*.

Of the existence of the elements of the composition of calculus in the saliva there can be no question. Chemical analyses of this fluid, direct from the glands, place all doubt upon the subject at rest. Thus it is seen that the chief earthy constituents which enter into the formation of this substance are contained in the saliva. It may also exist in solution in the mucous fluid of the mouth.

That the deposition of calculus may take place on one side of the mouth without a similar deposit on the opposite side furnishes no evidence in support of the doctrine which has been advanced, that it is an exhalation from the capillaries of the mucous membrane of the gums. The mastication of food is, with most persons, performed more on one side of the mouth than on the other; that this function prevents, in a great degree, the accumulation of calculus on the organs immediately concerned is a fact with which every dentist must be familiar. Hence its frequent collection on the teeth of one side and not on those of the other. And that it is ascribable to this circumstance is susceptible of positive proof. If, on the removal of the calculus from the teeth of a person in whose mouth it has collected only on those of one side, mastication be afterward altogether performed on this side, it will not reaccumulate on them; and if requisite attention to the cleanliness of the teeth on the other side be not observed, it will soon collect there, although these teeth had before remained free from it.

Again, it often happens that disease of a severe character is excited in the gums by the use of mercurial medicines and other causes, and yet but a small quantity of calculus collects on the teeth; but that any condition of the general system, or of the mouth, tending to make the fluids of this cavity more viscid, promotes its formation is undeniable. There are, however, some temperaments much more favorable to its production than others; and it is a well-established fact that the mucous membrane of those in whose mouths it accumulates in largest quantity is the most irritable, and the buccal most viscid. Again, if it were deposited by the mucous fluids of the mouth, it would collect in largest quantities on those teeth which are less abundantly bathed in the saliva; as, for example, the anterior surfaces of the upper incisors and cuspids, while those opposite to the mouths of the ducts which discharge this fluid into the mouth would be less liable to deposits of calculus than any of the other teeth; whereas the contrary is found to be the case.

The conclusion, therefore, is, that this earthy matter is chiefly a salivary deposit and takes place in the following manner: It is precipitated from the saliva, as this fluid enters the mouth—especially when the secretion is sluggish—upon the surfaces of the teeth opposite the openings into the ducts from which it is poured. To these its

particles become agglutinated by the mucus always found, in greater or less quantity, upon them. Particle after particle is deposited, until it sometimes accumulates in such quantities that nearly all the teeth are almost entirely incrustated with it.

As regards the points of deposit of salivary calculus, the greatest quantities are found opposite the mouths of the ducts of the salivary glands, upon the lingual surfaces of the inferior incisors, cuspidati and bicuspidi, and the buccal surfaces of the superior molars. The necks of the teeth, about the free margins of the gums, afford favorable points for its collection, as here the saliva is longer retained and its calcareous ingredients precipitated than upon more exposed parts. It first collects about the necks of the teeth in semicircular or crescent-like lines close to the enamel, under the edge of the gums, and a nucleus being once formed it rapidly encroaches upon the crown, where it is deposited more abundantly. Certain varieties of salivary calculus adhere to the necks of the teeth with great tenacity, and often progress as far as the apex of the root, until the teeth are deprived of their support and their roots left denuded and exposed. Salivary calculus is never deposited on the flesh, but only upon such substances as represent the teeth or form nuclei, as artificial teeth, for example. It is sometimes deposited in the ducts, which may be owing to a sluggish condition of the saliva, in a form known as ranula, and has been removed in a mass as large as a hazelnut.

M. Robert presented to the Anatomical Society of Paris a hog's bristle, which had been forced into the duct of Wharton, densely covered with a thick salivary concretion.

From the fact that salivary calculus is often found upon parts where the saliva cannot be retained for any length of time, it is evident that it is sometimes precipitated as soon as this fluid enters the mouth.

EFFECTS OF SALIVARY CALCULUS UPON THE TEETH, GUMS, AND ALVEOLAR PROCESSES.

Although salivary calculus does not directly act injuriously upon the substance of the teeth, but, on the contrary, preserves the part it covers from the action of chemical agents, yet the effects of the presence of this substance are always pernicious, though sometimes more so than at others. An altered condition of the fluids of the mouth, diseased gums, and not unfrequently the gradual destruction of the alveolar processes, and the loosening and loss of the teeth, are among the consequences that result from it. But besides these, other effects are occasionally produced, among which may be enumerated tumors and spongy excrescences of the gums of various kinds, necrosis and exfoliation of the alveolar processes and of portions of the maxillary

bones, hemorrhage of the gums, anorexia, derangement of the whole digestive apparatus, and foul breath, catarrh, cough, diarrhea, diseases of various kinds in the maxillary antra and nose, pain in the ear, headache, melancholy, hypochondriasis, etc. So irritating is its presence that wherever it comes in contact with the gums and alveoli it causes their absorption, which in some cases may, at first, be attended with little or no inconvenience; while in others considerable inflammation, ending in suppuration of the gums, may result, extending to the mucous membrane of the mouth. Periostitis and necrosis of the alveolar processes are also results of the irritating action of this substance. The character of the effects, however, both local and constitutional, depends upon the quantity and consistence of the calculus, and upon the temperament of the individual as well as the state of the general health; the two former of these are determined by the two latter and by the attention paid to the cleanliness of the teeth. If this last be properly attended to, salivary calculus, no matter how great the constitutional tendency to its formation, will not collect in large quantity upon the teeth. The importance, therefore, of its constant observance cannot be too strongly impressed upon the patient, especially in those in whom there exists a great tendency to its deposition.

The teeth and their contiguous parts suffer more from accumulations of this substance than from almost any other cause. Caries is not much more destructive to them. When permitted to accumulate for any great length of time the gums become so morbidly sensitive that a tooth-brush cannot be used without causing pain; consequently, the cleanliness of the mouth is not attempted, and thus, no means being taken to prevent its formation, it accumulates with increased rapidity, until the teeth, one after another, fall in quick succession victims to its desolating ravages.

It sometimes not only undermines the constitution by occasioning discharges of fetid matter from the gums and corrupting the fluids of the mouth, but it also renders the breath exceedingly unpleasant and offensive. So nauseating and disagreeable is the odor which some descriptions of calculus exhale that the atmosphere of a whole room is contaminated by it in a few minutes.

MANNER OF REMOVING SALIVARY CALCULUS.

This is an operation of great importance to the health of the gums, alveolar processes, and teeth. But from a misconception of its nature, rather than from fear of pain, many are much opposed to it; and, notwithstanding the universal admiration in which clean and white teeth are held, they will suffer the beauty of these organs to be destroyed

rather than submit to its performance. There are some, indeed, who, though scrupulously particular in everything that regards dress, seem, nevertheless, to consider cleanliness of the mouth as unworthy of notice.

For the removal of calculus from the teeth a variety of instruments are necessary, which should be so constructed that they may be easily applied to every part of every tooth. Those in common use among dental practitioners are so very similar in their shape and so well known that we do not deem it necessary to point out the minute differences of construction, or even to give a general description of the instruments themselves. The instruments should be light, made with ivory, ebony, or cocoa handles, and tapering from a little above the ferule both ways; and the points of the instruments should be delicately shaped, so as readily to pass below the free edge of the gum. The success of the operation depends much upon the careful removal of every particle of deposit, for which a heavy, clumsy, or large-bladed instrument is wholly unsuited. If any particles of calculus be suffered to remain, they will irritate the gums and serve as nuclei for immediate re-accumulations.

Drs. F. Abbott's and How's sets of scalers, represented in the following figures, are well adapted for removing salivary calculus from all parts of the teeth.

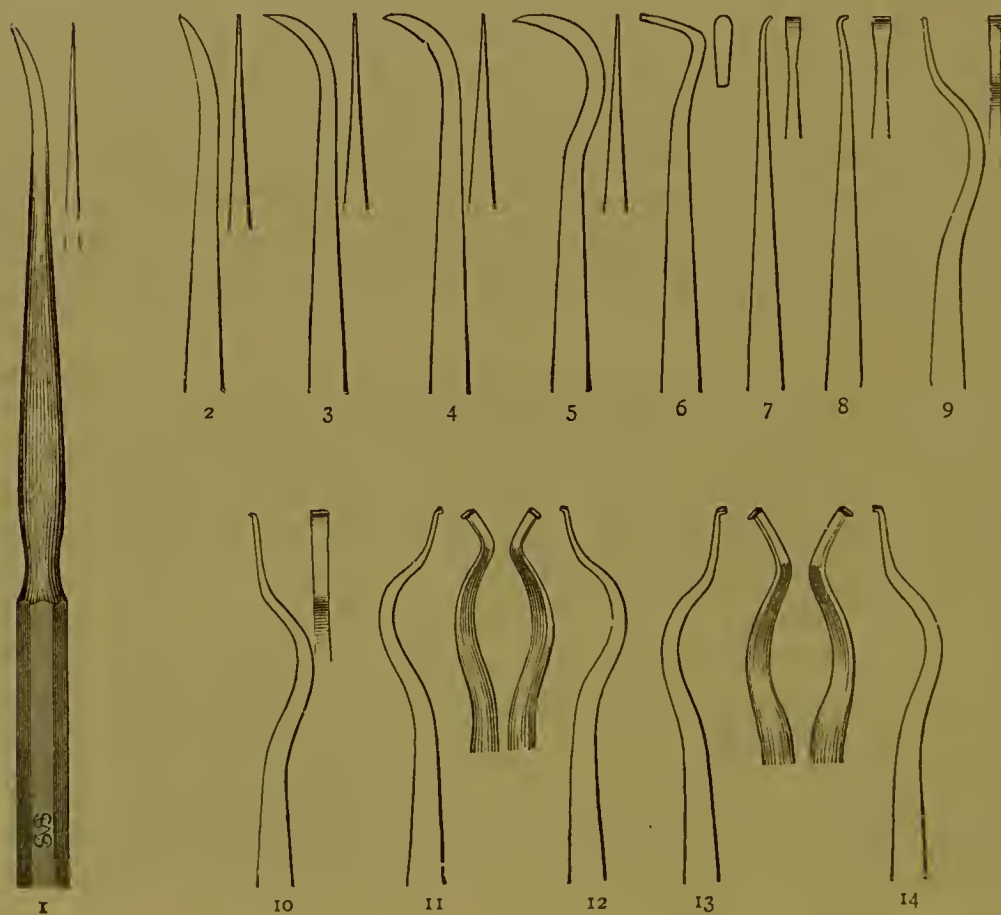


FIG. 140.

The adhesion of salivary calculus to the teeth is sometimes so great that considerable force is required for its removal, even when the sharpest and best-tempered instruments are employed, but ordinarily it may be removed with ease. Considerable tact, however, is necessary to perform the operation in a skillful manner; more than most persons, from its apparent simplicity, imagine. This skill can only

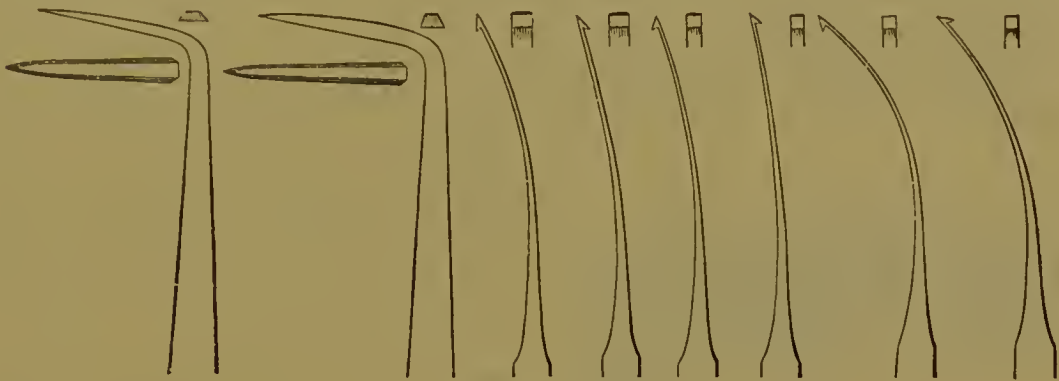


FIG. 141.

be acquired by practice. Calculus may be taken from the outer and inner surfaces of the teeth without much difficulty, but the removal of it from between them is more troublesome, and can only be effected by means of very thin, sharp-pointed instruments. Many, however, prefer scaling instruments with slender points, such as are represented by Fig. 141, which are used with a pushing motion in a direction from



FIG. 142.

the hand, instead of toward the hand. Fig. 142 represents a set of five scalers suggested by Dr. How.

In removing this substance from the teeth the point or edge of the scaling instrument should be applied below the deposit, between it and the gum, and passed well under, until it comes in contact with the surface of the tooth, and the mass scaled off in the direction of the cutting edge or grinding surface.

Care is necessary that the edge of the instrument does not roughen the tooth substance, especially the dentine, beyond the enamel. After the removal of the greater part of the deposit, the instrument should be lightly passed over the surface, to detach any particles which may remain, especially upon the approximal surfaces. After the use of the scaling instruments finely pulverized pumice or silex should be applied on a piece of orange wood so shaped as to reach all parts on which the deposit has collected.

The wood-points of various forms, charged with finely-powdered pumice or silex and rotated by means of the dental engine, are very useful for removing the discoloration caused by salivary calculus and the dark mucous deposit, which often cause the teeth to present quite an unsightly appearance.

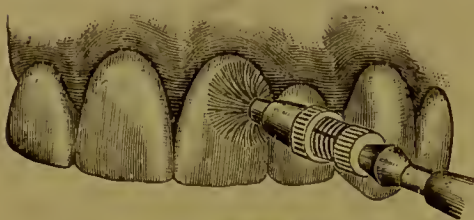


FIG. 143.

The small tooth-polishing brushes represented by Fig. 143, and the soft-rubber polishing cups suggested by Dr. J. B. Wood, Fig. 144, both

operated by the dental engine, will cleanse teeth from remains of calculus after use of scalers and from discoloration, even under the free borders of the gums. The cervical margins of fillings may also be polished by the small brushes and cups.

Where the surface of the enamel or dentine is found to be rough and without the natural polish, after the use of the pumice or silex, Arkansas stone and the bur-nisher may be applied with advantage, and a finely polished surface obtained.

Several sittings are sometimes necessary for the completion of the operation, especially when the calculus has accumulated in very large quantities. In all cases of this sort it should be first removed from between the edges of the gums and the necks of the teeth. During

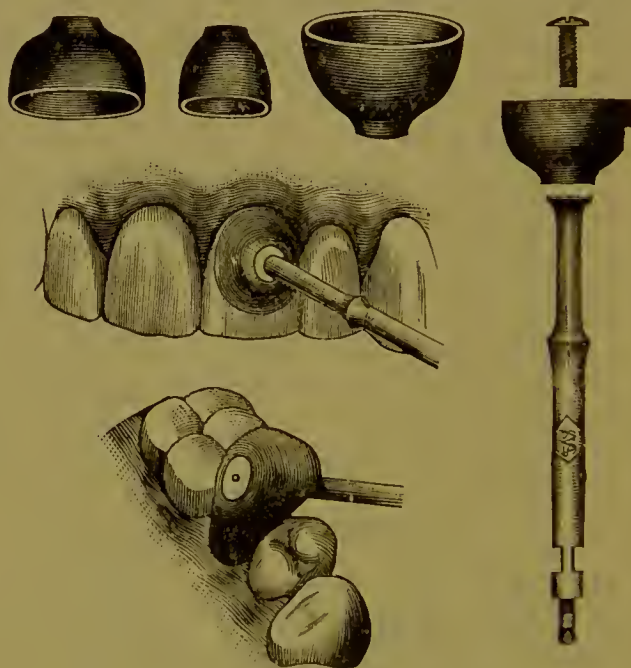


FIG. 144.

the intervals between the several operations the mouth should be gargled several times a day with some cooling and astringent wash ; but on this subject more particular directions will be given in another chapter.

During the removal of calculus from the teeth the gums often bleed very freely ; and when much swollen and spongy it may be well to promote it by holding tepid water in the mouth. When the lower incisors are loose, as is often the case, the operation should be proceeded with very cautiously, and the teeth supported by the fingers of the left hand holding the jaw, especially when the calculus is very hard and adheres with great tenacity.

Chemical agents are sometimes employed for the removal of salivary calculus, especially such of the vegetable and mineral acids as are supposed to have less affinity for the lime of the teeth than the phosphoric acid with which it is combined ; but it is scarcely necessary to say that any acid capable of dissolving tartar will act upon these organs. The use of all such agents should be most scrupulously avoided. Nearly all acids, both mineral and vegetable, as has been shown in another part of this work, are prejudicial to the teeth. Their careless administration by physicians is a fruitful source of injury to the teeth. And they certainly should form no part of any dentifrice, or be in any way used for the removal of stains of any kind from the teeth.

Pyrozone, in three or five per cent. solutions, is recommended for its softening action upon any incrustations about the teeth, thus rendering their removal easy, and causing no injury to the tooth structure or on myxomatous tissues. Care should be taken, however, that the five per cent. solution does not come in contact with the gum, as its effect is more or less painful for a short time.

SANGUINARY OR SERUMAL CALCULUS.

By this title Dr. L. C. Ingersoll designates a structureless calcareous deposit found at the apex of the root of a tooth, or sometimes extending in a line of granules along the root from the apex to the neck of the tooth, or again encircling the root immediately beneath the free margin of the gum. Being of sanguinary origin, it is found only where the serum of the blood is present, which, being decomposed, gives up its lime salts and affords material for the deposit, which is stained with the hematin of the blood. This form of calculus is derived from the serum that exudes from the diseased tissue, and its superior hardness is due to its being more purely mineral than salivary calculus, and it is generally of a black or dark-green color. Sanguinary calculus is deposited upon the roots of the teeth,

and not upon their crowns, as is the case with salivary calculus, being often found upon the very apex of the roots. It also differs in another respect from salivary calculus; the sanguinary, resulting from the disorganization of blood and ulceration of tissues, is in the form of dark, hard granulations approaching crystallization. The root of the affected tooth is denuded of its cementum, and the granular deposit so closely adheres that its removal is quite difficult. Sometimes it is found immediately beneath the margin of the gum, in the form of a dark, hard, rough ring, which may occasionally be visible through the gum in the form of a dark circle. A viscid, serous fluid may exude from about the neck of the tooth under slight pressure, the result of the ulceration which gives rise to the deposit. This fluid is not of the same nature as the pus from an abscess, being watery and nearly odorless, and composed, in a great part, of the serum of the blood. While salivary calculus causes inflammation, sanguinary calculus is a result of inflammatory action, and is found upon teeth affected with ulceration. The method of removing sanguinary calculus is referred to in the treatment of alveolar pyorrhea.

MUCOUS DEPOSIT ON THE TEETH.

While persons of all ages are subject to deposits of salivary calculus, there is a mucous deposit to which the teeth of children are especially liable, in the form of a brown or a green stain, which has been erroneously called green tartar. This deposit is generally found upon the labial surfaces of the front teeth, more especially upon those of the upper jaw, and varies in color from a light brown to a dark green. From its not collecting upon the posterior teeth and upon the lingual surfaces of the inferior front teeth opposite the mouths of the ducts leading from the salivary glands, there is every reason to conclude that this deposit is not precipitated by the saliva, and hence is altogether different in its origin from salivary calculus. It is generally considered to be a deposit from the mucus, when this secretion is in a more acid condition than is natural. From its effects upon the teeth when it is allowed to remain on them for a considerable time, and also from the fact that it is most abundant when the mucus is secreted in large quantities and of a decidedly acid reaction, there is little doubt as to its origin from this secretion.

That it is not deposited on all parts of the teeth is no reason for doubting the correctness of this theory, when we consider that the parts upon which it is found are those protected from the friction of food and the movements of the tongue and the flow of the saliva.

This form of discoloration of the enamel is indicative of an irritable condition of the mucous membranes and viscosity of the fluids

of the mouth. Sour eructations, vomitings, diarrhea, and dysentery are not infrequent with those whose teeth are thus affected. While the presence of this green stain on lately erupted teeth is almost a certain indication of softened enamel, this is not the case when it is deposited on adult and very dense teeth. In the latter case it does not appear to be a precipitate from the mucus, as salivary calculus is from the saliva, but is rather a growth of fungi upon the surface, and it is yet an open question whether it develops its own acid, as in the case of the "sprosspilz" lately described by Dr. Miller, or whether it retains the neutral secretions to the acidulated stage.

According to Wedl, it may "readily be demonstrated that the deposit is a green, greenish-yellow, uniformly minutely granular mass which is morphologically identical with the matrix of the leptothrix."

In regard to the effects of this mucous deposit upon the teeth, while salivary calculus tends to preserve the portion of tooth-substance on which it is precipitated, this green stain so erodes the enamel that decay advances in the part which it covers, more or less rapidly, according to the quality of the teeth and the length of time it is allowed to remain. The removal of this mucous deposit requires more skillful manipulation than that of salivary calculus, on account of its being a thin film entering into the substance of the enamel, rendering it difficult to detach without injury to the tooth substance; whereas salivary calculus is deposited in such quantities as to leave thick incrustations, which are readily scaled off from an uninjured surface. Where the erosion caused by this mucous deposit is but slight, it may be removed by Arkansas or Superior stones, or by finely powdered silex or pumice stone and water applied on a stick of hard, fine-grained wood, such as orange wood or hickory; the point of the piece of wood being so formed as to adapt it well to the surface on which it is to be used. The wood-points or small brushes, or soft rubber cups, charged with either of the powders referred to, and rotated by means of the dental engine, will prove very serviceable for such an operation. After all the discoloration is removed by the means just referred to, the surface should be well burnished with a steel burnisher and a solution of pure Castile or white Windsor soap. Pyrozone in five per cent. solution is also useful in removing this green stain, care being taken that it does not come in contact with the gum tissue. When, however, the effects of this mucous deposit are more serious, the enamel not only being discolored but deeply eroded, it is necessary to make use of the corundum point, rotated by means of the dental engine, the enamel chisel, or file, to remove the injured surface. The enamel chisel is to be preferred to the file in all cases where it is applicable; and the plain surface thus obtained should be polished with fine silex or pumice stone, Arkansas or

Superior stones, and the burnisher. Care is necessary in the use of the enamel chisel, to avoid wounding the neighboring soft tissues. To prevent the possibility of such an accident and to enable the operator to have control over his instrument, the chisel should be held firmly with the hand in such a manner as to allow the thumb to rest on an adjoining tooth. When the dentine is very sensitive, as is frequently the case, a proper agent for allaying the sensitiveness may be applied from time to time to the surface, as the operation of cutting it away proceeds. (See "Treatment of Sensitive Dentine.")

CHAPTER X.

NECROSIS AND EXFOLIATION OF THE ALVEOLAR PROCESSES.

THE alveolar processes, as well as other osseous structures, are liable to necrosis or loss of vitality. When their connection with the periosteum—the source from whence they derive their nourishment and vitality—is destroyed, death follows as a necessary consequence. The loss of vitality may be confined to the socket of a single tooth, but more frequently it extends to several, and sometimes to the alveolar border, occasionally including a part or the whole of the jaw. It may occur in either jaw, but it is more liable to take place in the lower than in the upper. When confined to the alveoli the dead part is never wholly replaced with new bone, but examples are on record of the re-

generation of a large portion of the lower jaw.



FIG. 145.—SECTION OF NECROSSED LOWER JAW.

When one or more of the cavities of the teeth lose their vitality, nature exerts all her energies to separate the dead from the living bone; this process, technically termed *exfoliation*, is supposed by some to consist in a sort of suppurative in-

flammation, but there is reason to believe it is effected by the action of a corrosive fluid poured out from the fungous granulations of the living bone in immediate contact with the necrosed part. During the process of exfoliation a thin, acrid matter is discharged from one or more fistulous openings through the gums or from between them and the necks of the teeth; the gums, having lost their connection with

the necrosed bone, become soft and spongy, and assume a dark purple appearance, are preternaturally sensitive to the touch, and bleed from the most trifling injury.

The subject of a case worthy of notice was a lady of a cachectic habit, about thirty-five years of age. The necrosis resulted from inflammation of the peridental membrane, occasioned by irritation produced by the roots of four incisors upon which pivot teeth had been placed, which, however, had been removed some two or three weeks before the author saw the patient. At this time necrosis had extended not only to the sockets of these teeth, but also up to the nasal crest of the maxillary bone, and the process of exfoliation had already proceeded so far that he was enabled to remove the entire piece, the appearance of which is represented in Fig. 146. A few weeks after the removal of this piece he again saw the patient, and, on examination, found a large portion of the palatine plate of the bone in a necrosed state; but the process of separation had not yet proceeded far enough to enable him to remove it.



FIG. 146.

The accompanying engraving, made from a drawing furnished the author by Dr. Maynard, represents a case of necrosis and exfoliation

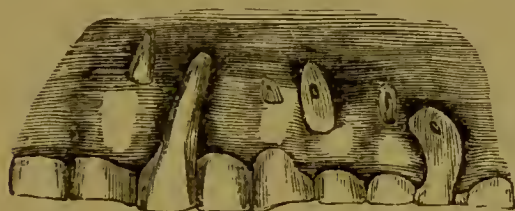


FIG. 147.

of a portion of the outer wall of the alveolar ridge, and the consequent protrusion of the roots of the teeth on one side of the mouth.

The alveolar process in relation with the superior central incisors appears to be more susceptible to

necrosis than other portions, and this may be ascribed to such causes as diminished vitality occurring during conditions of depression and debility, the liability of such a prominent part to mechanical injury, and the effect of suppurative inflammation upon a portion of the process which possesses a less degree of restorative power than other portions better protected by muscular tissue.

Phosphor-Necrosis.—Necrosis of the bones of the jaws may also result from exposure to the fumes of phosphorus, as in the manufacture of matches, for example.

The disease, when due to such a cause, usually commences about a carious tooth, or in an alveolar cavity opened by the extraction of a tooth, and is sometimes complicated with affections of the lungs and air-passages.

In phosphor-necrosis there is a peculiar pasty appearance of the face, puffiness of the cheeks, and considerable pain and swelling in the

affected jaw. Instead of the separation of a sequestrum, the dead bone becomes incrustated with a pumice-stone-like material, which adheres very firmly to it. Abscesses form and discharge externally through the skin of the cheek, and leave fistulous openings for the escape of the matter.

Causes.—The immediate cause of necrosis is the death of the periosteum, occasioned by inflammation. The cause of this, as has already been shown, is, in a large majority of the cases, dental irritation. Necrosis of the alveolar process occurs very frequently while the system is under the influence of mercurial medicines, and during bilious and inflammatory fevers, and certain other constitutional diseases, as syphilis, smallpox, etc. It may also result from mechanical injuries and the devitalizing effect of such agents as arsenious acid and chlorid of zinc, when applied to destroy pulps of teeth, and so obtund the sensibility of dentine, etc., etc.

Treatment.—The treatment of cases of this kind consists in the removal of the sequestra, strict attention to cleanliness, and the free use of chlorinated washes. As soon as the dead portions of bone become separated from the living, and can be easily removed, they should be taken away with a pair of forceps. Should the removal of a considerable portion of the bone of the jaw be requisite, it is seldom necessary to interfere with the skin or make an external incision. The whole of the lower jaw can be removed in this manner by dividing it at the chin, and after separating all the attachments of the soft parts with the knife, drawing out each half at a time.

To correct the offensive odor and disagreeable taste occasioned by the constant discharge of fetid matter, washes of chlorid of sodium may be employed.

There is no remedy, perhaps, that gives more satisfaction in the treatment of necrosed alveolar process and carious bone, than dilute aromatic sulphuric acid, combined with a small quantity of tincture of capsicum, using alternately the antiseptic known as "listerine." Prior to the application of such agents, the diseased parts should be syringed with tepid water, and this cleansing process continued throughout the entire course of treatment. While cold water will coagulate pus and unhealthy secretions, which are irritating by their pressure, warm water will produce the opposite effect, and is a useful adjunct to the antiseptic remedies. The removal of teeth, in cases of necrosis of the alveolar process, should only be resorted to after mature consideration, for it frequently happens that the affection is confined to the labial walls, and if it is arrested new bone may be formed to such a degree as to give stability to the teeth in relation with the affected part.

Condy's fluid, or a solution of permanganate of potash, a weak solution of carbolic acid, or a solution of chlorinated soda, will answer as disinfectants and correct the fetor. The strength of the patient should be supported by stimulants and tonics, and good nourishment.

ABSORPTION OR GRADUAL DESTRUCTION OF THE ALVEOLAR PROCESSES.

This disease, to which the term "phagedenic pericementitis" has been applied, is a destruction of the walls of the alveolar cavities of the teeth, by a process of absorption which is always preceded by a corresponding loss of the peridental membrane, and which is usually the result of a chronic form of inflammation.

It is always accompanied by a slight increase of redness, tumefaction, and a shrinkage of the edges of the gums (ulatrophia); but the diseased action here is so inconsiderable as often to attract little attention. It is also attended by a slight discharge of purulent matter from between the margin of the gum and tooth; but the quantity is so small that it usually escapes observation. The peridental membrane participates also in the diseased action, but this is so often confined to the corresponding wall of the process which is absorbed away, that the tooth often remains quite firmly articulated, after the wasting of its socket has proceeded even so far as to expose more than half of the root. Indeed, the affection appears to be closely allied to chronic inflammation and tumefaction of the gums.

The progress of the disease is often so slow that ten, fifteen, or twenty years are required to affect very perceptibly the stability of the teeth in their cavities. The commencement of this destructive process is usually first observed around the cuspid teeth; sometimes it makes its appearance on the alveoli of the palatine roots of the first and second upper molars, and occasionally it goes on here for years before it affects the cavities of any of the other teeth.

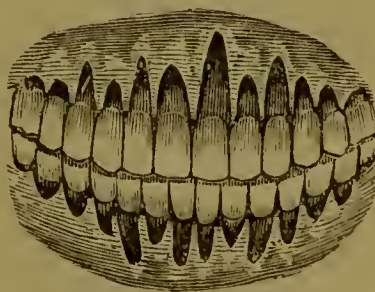


FIG. 148.

The teeth, after their roots have been partially exposed, become, as might naturally be supposed, more susceptible to impression from heat and cold, and more easily affected by acids or saccharine matters; but this is about the only manifest inconvenience experienced from the disease until the teeth begin to loosen in their cavities and are gradually displaced.

In Fig. 148 is represented a case in which the roots of the teeth have become considerably exposed by the gradual wasting of their

sockets—the destruction being, as is usual, greatest toward the median line.

Apparently the absorption of the bone occurs as a consequence of the inflammation of the peridental membrane.

Causes.—The cause of this peculiar affection has never been very satisfactorily explained. Some have supposed that, inasmuch as it occurs most frequently in persons of advanced age, it results from a decline of the vital powers of the body, independently of local causes; but, as it is often met with in middle-aged persons whose constitutional health is unimpaired, we doubt the correctness of the opinion. In all cases which have come under our observation, whether in middle-aged or very old persons, the teeth indicated an excellent innate constitution, whatever may have been the state of the general health at the time. In every instance these organs were possessed of great density, and it is evident that teeth endowed with the power of resisting to so late a period of life the action of the causes of decay, to which all teeth are more or less exposed, must be possessed of extreme hardness, and, necessarily, a corresponding low degree of vitality. In view of this fact we have been led to the opinion that the teeth themselves may act to some extent as the mechanical irritants to the more highly vitalized parts with which they are immediately connected, causing an increase of vascular action in the periosteum of the thin edges of the alveoli and margin of the gums. This abnormal condition is attended by a slight secretion of purulent matter observed between the edges of the gums and teeth. It is to the corrosive action of this purulent matter that the gradual destruction of the alveoli has by some been attributed; but it is more probably a result of the obscure disease than its cause.

This affection has been ascribed to the presence of salivary and sanguinary calculus, the use of charcoal powder as a dentifrice, and the application of a very stiff brush for cleaning the teeth; but when caused by these two latter agents the absorption does not progress to such a degree as when it is owing to a want of congeniality between the tooth and the more highly vitalized structure surrounding its root, or the other causes before referred to.

A later theory as to the cause of this affection has been advanced by Dr. Arkoevy, who believes that it is caused by a certain fungous formation found in close connection with the wasting of the alveoli and the gingival margin, as well as the subsequent loosening of the teeth; and that it is quite different from *leptothrix buccalis*, although it is in developmental relation with it.

Dr. G. V. Black also states that it is probable that the disease is caused and maintained by the presence of some peculiar fungus or

form of microorganism, and that it is infectious, this tendency being shown by the loss of the neighboring teeth. Others have ascribed this affection to a peridental inflammation arising from a gouty or rheumatic diathesis.

Treatment.—From what has been said concerning the cause of this affection, it is obvious that a cure cannot always be effected; its progress, however, may sometimes be arrested. The first step in the treatment is to remove all irritants, such as deposits of calculus, from the necks and roots of the teeth, and correct the nature of the fluids of the mouth abnormal in character by constitutional treatment, the use of lime-water, and a detergent dentifrice. Should such means prove ineffectual, the application of a solution of iodine and creosote or carbolic acid, or chlorid of zinc to the margins of the gums will often be of benefit in retarding the absorption and inducing a more healthy action. The secretion of the purulent matter, to the action of which some attribute the destruction of the alveoli, is the result of a disease in the peridental membrane and the edges of the gums, arising from some peculiar physical condition of the teeth, the progress of which may be retarded by cleaning the teeth frequently and thoroughly, using the precaution each time to remove the purulent matter from between the edges of the gums and teeth, lest, if allowed to remain, it should become putrescent, and in this condition act as an irritant to the gum. For this purpose the parts should be washed with a solution of peroxid of hydrogen and bichlorid of mercury (one grain of the latter to the ounce of the former), after which much benefit will be derived by applying a 30 per cent. solution of chlorid of zinc, by means of a camel's-hair brush, to the margins of the gums. As the margin of the gum is inflamed, and a sulcus or pocket formed between it and the tooth, the use of the agents above referred to will promote healthy granulations.

The judicious application of pressure upon the gum has, in some cases, restored the receded portion, to a degree, at least.

Dr. G. V. Black suggests that when there is rapid destruction of the tissue and a considerable portion of the alveolar wall* has been destroyed, and much of the peridental membrane detached from the root of the tooth, it is better to cut away some parts of this with instruments until firm bone is felt, but that care should be taken not to injure the gingival margin in any manner. The soft tissue farther up, however, may be lacerated without evil result, but the margin of the gum should be preserved so that it may close around the neck of the affected tooth.

Where it is desirable to preserve a valuable tooth, one of the roots of which has been denuded of gum and process, such root may be

amputated by the use of a fissure-burr operated by the dental engine. The root should be cut off as close to its union with the crown as possible and the surface made smooth. It is advisable to fill all the roots with gold before amputating.

HYPERTROPHY OF THE WALLS OF THE ALVEOLAR CAVITIES.

A tooth is sometimes slowly forced from its place by a deposit of bony matter in the bottom or on the side of the socket. Two, or even three, teeth may be gradually displaced at the same time, by exostosis of the alveoli. The deposition usually proceeds so slowly that one or two years are required to effect a very perceptible change in the situation of a tooth. The upper central incisors are more frequently affected than any of the other teeth, and the deposit occurs oftener at the bottom than on the sides of the alveoli. In the first case, the tooth is gradually protruded from the socket; in the other, it is either pressed out of the arch or against one of the adjoining teeth. Irregularity in the arrangement of the teeth is, in this manner, sometimes produced, especially when more than one socket is affected at the same time. The central incisors are sometimes forced apart; at other times they are forced against each other and caused to overlap. The deposition of bone, however, being generally confined to the bottom of the sockets, the teeth are more generally thrust from their alveolar cavities. When this occurs with a person whose upper and lower teeth strike directly upon each other, it occasions much inconvenience, for the elongated tooth must either be thrown from the circle of the other teeth, or, by striking its antagonist, prevent the jaws from coming together.

Causes —Whereas excessive irritation causes absorption or destructive pathologic conditions, slight irritation may cause new formations; hence, slight, but long-continued irritation of the peridental membrane may produce exostosis of the alveolar cavities; it may also be caused by the gradual elongation of a tooth which has lost its antagonistic teeth, and the consequent filling up of the alveolar cavity. A diseased state of the gums can have no agency in the production of the exostosis, for it most frequently occurs in individuals whose gums are perfectly healthy; and if it were the result of any constitutional tendency, all the teeth would be likely to be affected by it.

Treatment.—When the exostosis is on the side of the alveolar cavity, the tooth cannot be restored to its natural position; but when it is in the bottom of the cavity the elongated organ may, from time to time, as it is forced from the alveolus, be filed or ground off even with the other teeth; but in doing this care should be taken to avoid as much as possible the unpleasant jar which the file or corundum disc is so

apt to cause, and which might, in such cases, excite the peridental membrane to increased activity and a more rapid deposit. This will remove the deformity and prevent its displacement by the antagonizing tooth. By this simple operation, repeated as occasion may require, it is preserved for years, and rendered almost as useful as any of the other teeth. Steady pressure in the proper direction, applied to the crown of a tooth so affected, may also prove serviceable at an early stage.

CHAPTER XI.

DISEASES OF THE TEETH.

NECROSIS OF THE TEETH.

THE term *necrosis* implies death, but when this term is applied to a tooth, it usually signifies loss of vitality of the pulp; for it often happens that a degree of vitality is kept up in the outer portion of the dentine and the investing cementum by the peridental membrane long after the devitalization of the pulp. When other bones are affected with necrosis, the dead part is thrown off and the loss supplied by the formation of new bone. But the teeth are not endowed with the recuperative power which the process of exfoliation calls for.

The density of a tooth may not be sensibly affected by the mere loss of vitality; but so great a change takes place in the appearance of the organ, that it may readily be detected by the most careless observer. After the destruction of the lining membrane, the tooth gradually loses its peculiar semi-translucent and animated appearance, assuming a dingy or muddy-brown color; and this change is more striking in teeth of a soft, than in those of a hard texture. The discoloration, too, is always more marked when the loss of vitality has resulted from a blow, than when produced in a more gradual manner. The discoloration is partly owing to the presence of disorganized matter in the pulp-cavity, and partly to the absorption of this matter by the surrounding walls of dentine.

After the destruction of the lining membrane, the tooth may receive a sufficient amount of vitality from the peridental membrane to prevent it from exerting a manifest morbid influence upon the parts with which it is immediately connected. Teeth have been retained under such circumstances with apparent impunity for many years. But when every part of a tooth has lost its vitality, it becomes an

extraneous body. When this happens, inflammation of the cavity ensues, the gum around it becomes turgid and spongy, and bleeds from the slightest injury, and the organ gradually loosens and ultimately drops out. In the meantime the diseased action frequently extends to the cavities and gums of the adjoining teeth.

The front teeth, being more exposed to injuries from violence, are more liable to necrosis than the molars.

Causes.—Necrosis of the teeth may be produced by a variety of causes, such as protracted fevers, the long-continued use of mercurial medicines, by caries, and by external violence. The immediate cause, however, when not occasioned by a blow sufficient to destroy the vascular connection of the tooth with the rest of the system, is inflammation and suppuration of the lining membrane; but it may result from deficiency of vital energy and from impaired nutrition; for the author has met with several cases in which the loss of vitality could not be accounted for in any other way.

Treatment.—When a tooth deprived of vitality is productive of injury to the gums and to the adjacent teeth, it should be immediately removed; for, however important or valuable it may be, the health and durability of the others should not be jeopardized by its retention.

When necrosis of a tooth is apprehended, we should endeavor to prevent its occurrence by the application of leeches to the gums, and by gargling the mouth with suitable astringent washes, and the employment of such remedies as are useful in the treatment of periodontitis. If this plan of treatment is adopted at an early period, it will sometimes prevent the loss of vitality; but if long neglected, a favorable result need not be anticipated.

When the loss of vitality is confined to the crown and inner walls of the root, if the former is not seriously impaired by caries, it may be perforated, and the pulp-cavity and root cleansed, disinfected and filled in the manner as directed in another part of this work. If the necrosed tooth is an incisor, the perforation should be made from the palatal surface, provided the proximate surfaces are sound. But previously to the introduction of a filling, the decomposed surface of the walls of the pulp-cavity should be completely removed, and if this does not restore the tooth to its natural color, the process of bleaching should be resorted to.

Bleaching Necrosed Teeth.—To improve the appearance of a necrosed tooth which has become discolored from the dentinal tubuli absorbing the coloring matter from the blood, the following method may be pursued: First, remove all decayed matter from the crown-cavity, where such a cavity exists, taking care, however, to leave the enamel uninjured, and also as much of the dentine as is necessary for the

strength of the tooth. Pursue the same course with regard to the canal in the root, cleansing this carefully by means of a syringe and tepid water after the removal of decomposed matter with the nerve canal instruments. When the discoloration is recent and not more than a red tinge in degree, such treatment as has been described may prove sufficient; should it not be, however, owing to the length of time the discoloration has existed, and the hue is a brown, dark brown, or black, it is then necessary to resort to such agents as contain chlorin. Solutions of chlorid of soda, chlorid of lime, chlorate of potash, decompose organic substances by removing the hydrogen of their coloring matter. One of the most reliable of these preparations is the solution of chlorid of soda, known as "Labarraque's Disinfecting Fluid," which may be introduced on a pellet of cotton and allowed to remain in the tooth from thirty to sixty minutes, according to the degree of discoloration present. Repeated applications may be necessary in some cases before the object desired is accomplished. To prevent the caustic action of these agents on the soft parts, the canal in the root should be partly filled prior to their introduction, and care taken to prevent their coming in contact with the mucous membrane of the mouth by the application of the rubber-dam. The chlorid of lime is introduced in the same manner as the chlorid of soda, and is allowed to remain for five, ten, or fifteen minutes at a time, and its application repeated if necessary, the crown-cavity during the interval being protected by a temporary filling of Hill's stopping.

Dry, fresh chlorid of lime made into a paste with dilute tartaric acid has given satisfaction in many cases as a bleaching preparation; and in recent cases or in slightly discolored teeth, the plastic filling material known as oxychlorid of zinc, introduced into the crown cavity and worn as a temporary filling, has been effective in improving the appearance of a discolored crown. Oxalic acid, carefully protected, is also effective as a bleaching agent, applied in the form of a crystal introduced into the carious cavity and dissolved by applying to it a drop of water. Cyanid of potassium in solution will remove the stains caused by old amalgam fillings, but must be employed with great care, as it is a very active and deadly poison. In the use of all these agents it must be remembered that upon the cause of the discoloration will depend the efficacy of the chemical agent, and that chlorin will answer in some cases, owing to the nature of the agents instrumental in producing the discoloration, while cases of discoloration arising from the action of other agents will require such preparations as oxalic acid, etc.

After the action of the bleaching agent is no longer required a good practice is to fill the crown cavity of the tooth with either prepared

chalk or carbonate of magnesia, which may be secured by a temporary filling, and permitted to remain for several days; or a filling of the oxychlorid of zinc may be temporarily used, and a more permanent filling be subsequently introduced. Chlorid of zinc in the form of crystals may also be employed as a bleaching agent; also chlorin water injected repeatedly by means of a syringe; also chlorate of potash and chlorid of alumina. The peroxid of hydrogen has also been used successfully for bleaching discolored teeth, and its disinfectant properties add to its value. The following directions are given by Dr. A. W. Harlan:—

“After the root has been filled and the tooth is free from tenderness, apply the dam, dry the cavity, and remove all discolored dentine. Wash the cavity several times with fresh peroxid of hydrogen and place a few crystals of chlorid of alumina in the cavity, moisten with the peroxid of hydrogen, and wait from three to five minutes; wash the cavity thoroughly with distilled water, then apply a solution of 30 grains of borax to the ounce of water until the acid is entirely neutralized. Dry the cavity with hot air, and paint the interior with copal-ether varnish. When it is dry mix oxychlorid of zinc of the desired color and fill the cavity full; allow it to harden, then prepare the cavity for the gold filling and fill at once.”

The active agent is oxygen, and even when chlorin is used to bleach discolored teeth the cavity should be moistened with water, as the latter is essential, for the chlorin, having a great affinity for the hydrogen of the water, unites with it and liberates the nascent oxygen, which is the active agent.

Peroxid of hydrogen, peroxid of sodium, and pyrozone in five and twenty-five per cent. solutions are effective bleaching agents, especially the latter, which attack the hydrogen in the color compound, and when this is given off only water remains. Dr. Meeker's method is as follows: Apply the rubber-dam, and wipe out the prepared cavity with ammonia to neutralize possible acidity; then with a gold probe armed with a pellet of bibulous paper saturated with the twenty-five per cent. solution of pyrozone, liberally moisten the interior of cavity and outer surface of tooth, evaporating the solution with repeated blasts of cold air. Repeat this treatment, although thirty minutes will often suffice.

Electrolysis is also applied to the bleaching of discolored teeth by placing nascent oxygen in contact with the discolored surface. It is applied, according to Dr. W. B. Ames, as follows: First fill the root and moisten the cavity with acidulated water (one drop to the ounce of water, in order to render it a more effectual electrolyte), then apply a metal electrode connected with the negative pole of the battery in

contact with the moistened surface of the margin of the cavity, and pass a platinum needle, connected with the positive pole of the battery, over the surface to be bleached. Upon closing the circuit the oxygen of the water is liberated at the positive pole near the surface to be bleached, and the hydrogen is liberated at the negative electrode outside the cavity. Electrolysis is also recommended for the treatment of alveolar pyorrhea.

It should be remembered that the effect of these agents is to remove the organic or animal matter from the tooth-structure, and that their repeated application may cause the crown of the tooth to become frail and brittle.

HYPERCEMENTOSIS.

This disease, formerly designated "exostosis of the teeth," but now designated *hypercementosis*, and also *hyperostosis*, attacks no other part of a fully formed tooth than the root; for in the cementum alone, of the three osseous dental tissues, do we find that degree of vascularity which is a necessary condition of growth—normal or abnormal. It usually commences at or near the extremity, then extends upward, covering a greater or less portion of the external surface. It sometimes, however, commences upon the side of the root and forms a large tubercle; at other times the deposit of the new bony matter is spread over the surface of the root, often uniformly, but more frequently unequally. When it exists in a nodular form upon the roots, this deposit offers a very serious obstacle in the extraction of such teeth. The osseous matter thus deposited has usually the color, consistence, and structure of the cementum, though sometimes it is a little harder and assumes a yellower tinge. The enlargement is in fact an hypertrophied condition of this substance. Mr. Tomes, alluding to normal cementum, remarks: "When it is limited to a thin layer the lacunæ are altogether absent, and even canaliculi do not appear until a certain thickness is attained. In a longitudinal section of a front tooth the cementum near the neck will present a thin layer of transparent tissue, marked with faint indications of granularity, accompanied in some cases with an obscure linear appearance, suggestive of the idea that the calcification of parallel fibres had contributed to its production. Proceeding in the direction of the root, the cement thickens and is traversed here and there by canaliculi; and still farther down lacunæ make their appearance, first as a single series, then, with an increased thickness of the cementum, in numbers, the number generally depending

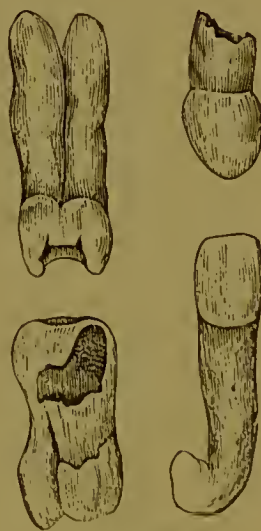


FIG. 149.

upon the thickness of the tissue." Those singular anomalies occasionally met with, where enamel, dentine, and cementum are mixed up in a shapeless confusion, are no exceptions to the rule that hypercementosis is confined to the cementum; for though classed under this head, these cases arise from the disruption of the formative membranes (possibly the result of violence), each secreting its peculiar tissue.

The deposit of osseous matter is sometimes so considerable that the roots of two or more teeth are firmly united by it. Fig. 149 represents some common examples of hypercementosis.

Fig. 150 *a* represents the circumscribed variety, and Fig. 150 *b* the diffused variety.

Hypercement is a product of the peridental membrane, and is formed in layers, the first of which is attached to the primary cementum in the same manner as the first layer of this latter substance is attached to the peripheral surface of the dentine. When the normal



FIG. 150.

cementum is fully formed the peridental membrane becomes inactive as a hard tissue producer, until some pathological condition causes it to again assume such a function.

In one instance the author was compelled to extract four sound teeth and nine roots; yet the pain was not at any time severe, but it was constant and a source of great annoyance to the patient.

Several years ago Prof. Gorgas, while demonstrating practical anatomy, discovered all the teeth in the mouth of one of the subjects (a negro girl about twenty-five years of age) to be in an exostosed condition. On the roots of one of the superior molar teeth the deposit of osseous matter measured three-fourths of an inch in diameter.

Teeth affected with hypertrophy of the cementum may be free from tenderness even under pressure or percussion, although the gum may, in some cases, be slightly congested; but the diagnosis of this affection is extremely difficult unless the enlargement of the root causes a prominence on the alveolar ridge, which is not often the case.

In many but not in all cases of this affection more or less discomfort and pain attend this deposit, owing to the enlargement of the

cementum with consequent pressure upon the nerves. When such an enlargement is in proportion to that of the alveolus, little or no pain may be experienced. The pain arising from the enlargement of the cementum is at times moderate though persistent, but in some cases it may be excruciating, and may be referred to distant parts of the face and head or ear and about the terminal branches of the fifth pair of nerves, thus resembling neuralgia.

Causes.—Most writers concur in attributing the proximate cause of hypertrophy of the cementum to irritation of the peridental membrane; but this is not, as some suppose, necessarily dependent upon any morbid condition of the crown itself, for it often attacks teeth that are perfectly sound. It seems rather to be attributable to some peculiar constitutional diathesis. Dr. Bödecker believes that a congenital surplus of pericementum in the patient is productive of the enlargement of the cementum, and that in this case the movement of the tooth in mastication would slightly exceed the normal degree, and that the constant irritation of the pericementum under such conditions might cause an increase in the amount of the cementum.

It never makes its appearance on the roots of temporary teeth, nor upon permanent teeth until the sixteenth or twentieth year, when the dental tissues are completely calcified.

Treatment.—When it is possible to discover the existence of hypercementosis at an early stage, iodid of potassium in large doses, and painting the gum over the affected root with such counter-irritants as a saturated tincture of iodine, or cantharidal collodion to produce a blister.

The disease having established itself does not admit of cure, and when it has progressed so far as to be productive of pain and inconvenience to the patient the loss of the affected teeth becomes inevitable. When the enlargement is very considerable and confined to the extremity of the root, and has not induced a corresponding enlargement of the alveolus around the neck of the tooth, the extraction of the affected organ is often attended with difficulty, and can only be accomplished by removing a portion of the alveolar wall of the cavity or fracturing it.

Some are of the opinion, however, that the deposit of osseous matter may be arrested and absorption excited, so as to make room for that already deposited, by the administration of iodid of potassium, as referred to above.

EROSION OF THE TEETH.

Erosion of the teeth, to which the name “denudation” was formerly applied, is a process in which the enamel and dentine of the teeth are dissolved or wasted away, the location of the affection being princi-

pally on the labial surfaces near the cervical margins. The approximal surfaces of the teeth are sometimes the seat of this affection, and in very rare cases it has appeared upon the lingual surfaces. It attacks the incisors more frequently than the canines, and sometimes extends to the bicuspid and first and second molars. It first appears as a slight cup-shaped depression and increases over a limited space until it forms a continuous horizontal groove, as regularly and smoothly constructed as if it had been made with a file, about one line or less from the free margin of the gum, the eroded surface being generally very sensitive, having a polished appearance and being sharply defined. (See Fig. 151.) After it has removed the enamel it commits its ravages upon the subjacent dentine, sometimes penetrating to the pulp-cavity. It rarely changes the color of the enamel, but the dentine, after it becomes exposed, assumes first a light, and afterward a dark brown color, retaining, however, a smooth and polished surface. This destructive process does not always commence at merely one point on the labial surface of the central incisors, as just described; it some-

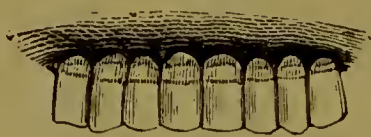


FIG. 151.



FIG. 152.

times attacks several points simultaneously. (See Fig. 152.) As it spreads these unite, and ultimately a deep excavation is formed with walls so smooth and highly polished that the tooth presents the appearance of having been scooped out with a broad, square, or round-pointed instrument. It is often confined to the incisor and canine teeth, and in some cases to the teeth on one side of the mouth only. This affection generally appears after the thirtieth year of age, and when the eroded surfaces become rough the change is generally due to the action of caries.

The progress of the affection is exceedingly variable. It is sometimes so rapid that the dentine becomes exposed within two or three years from the commencement of the disease; at other times its effect upon the enamel is scarcely perceptible for the first six or eight years after it makes its appearance. In the case of a lady whose teeth were thus affected the denuding process did not perforate the enamel for nearly twenty years. The dentine, after it is denuded of enamel, is generally quite sensitive and very susceptible to heat and cold; this is especially the case with the superior canines.

Causes.—Some writers suppose it is occasioned by chemical action, to which, however, there appears to be many valid objections. Mr.

John Tomes and also Mr. Salter ascribe it to the vigorous use of the tooth-brush or other friction, but such a cause is improbable. That this may increase the size of the horizontal groove is more than probable; that it may even in some cases determine the commencement of the groove is just possible. But no conceivable action of the brush could be an inciting cause of that form of the disease shown in Fig. 152. There is better reason for believing that this affection is due to a condition of enamel deficient in vital resistance, owing to some modification at the period of its formation, thus rendering it susceptible to the action of agents which it might, under more favorable circumstances, successfully resist; but microscopical examinations have failed to establish such a theory, as, according to Dr. Black, the erosion does not follow the developmental lines, which would be the case if portions of the teeth could be worn away on account of any softness from faulty development. The generally accepted theory is that this affection is caused by the action of an acid secretion, abnormal in character, or such constitutional acidity as may be present in a gouty diathesis, the movements of the lip assisting in the solution of the tooth-substance. Dr. W. D. Miller records the following experiment, which he regards as definitely settling the question as to whether or not erosion occurs in pulpless teeth: "We have all seen pulpless teeth which presented extensive erosions, but we have not been able to say that these erosions were not produced while the pulp of the tooth was still alive, and, as far as I am aware, no one has succeeded in refuting beyond all doubt the assertion that erosion attacks only teeth with living pulps. On the 7th of April, 1886, a piece of ivory was set, by means of cement, in the cavity of a right inferior bicuspid, where the loss of substance by erosion was so extensive that it would have exposed the pulp if the latter had not been protected by secondary dentine. On the 23d of April, 1888, the piece was removed for examination, and showed two very distinct parallel horizontal furrows. The surface had a very fine polish, characteristic of abraded dentine. No one examining the piece of ivory would hesitate for a moment to pronounce it a typical case of erosion."

Treatment.—In advanced stages of the affection its progress may be arrested by properly preparing the cavities and afterward filling them with gold; or, if the defective spaces will permit, porcelain sections or facings may be inserted. This, in the majority of cases, will prove successful. Should the grooves or pits when superficial become discolored it will be proper to use occasionally pumice or silex applied on a point of wood.

Erosion Associated with Abrasion.—This process was formerly treated under the title of "Chemical Abrasion," but as it appears to

be an affection of the teeth in which the effects of both erosion and abrasion from mechanical causes are combined it is considered under the head of erosion. It is of comparatively rare occurrence and commences on the central incisors, proceeding thence to the laterals, the cuspids, and sometimes, though very rarely, to the first bicuspid. Teeth thus affected have, when the jaws are closed, a truncated appearance; the upper and lower teeth do not come together, and they are rather more than ordinarily susceptible to the action of acids or of heat and cold. In other respects little or no inconvenience is experienced until the crowns of the affected teeth are nearly destroyed.

Its progress, as in the case of simple abrasion of the labial surfaces, is exceedingly variable. It sometimes destroys half or two-thirds of the crowns of the central incisors in two or three years; at other times seven or eight years are required to produce the same effect. In one case which came under our own observation the abrasion had extended to the bicuspid, and the central incisors of both jaws were so much wasted that on closing the mouth they did not come together by nearly three-eighths of an inch; yet two years only had elapsed since its commencement. In another case, where it had been going on for seven years, it had not extended to the cuspids, and the space between the upper and lower incisors did not exceed an eighth of an inch. The subjects of these two were gentlemen—the first aged about twenty-eight and the other twenty-one.

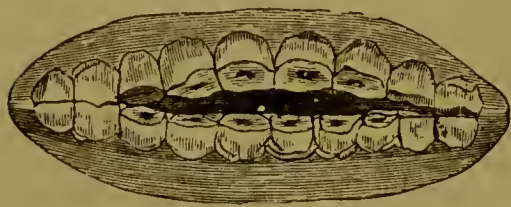


FIG. 153.

Mr. Bell gives an interesting case (Fig. 153) of a gentleman whose teeth were thus affected: "About fourteen months since (1831) this gentleman perceived that the edges

of the incisors, both above and below, had become slightly worn down, and, as it were, truncated, so that they could no longer be placed in contact with each other. This continued to increase and extend to the lateral incisors, and, afterward, successively to the cuspids and bicuspid. There has been no pain, and only a trifling degree of uneasiness, on taking acids or any very hot or cold fluids into the mouth. When I first saw these teeth they had exactly the appearance of having been most accurately filed down at the edges and then perfectly and beautifully polished; and it has now extended so far that when the mouth is closed the anterior edges of the incisors of the upper and lower jaws are nearly a quarter of an inch asunder. The cavities of those of the upper jaw must have been exposed but for a very curious and beautiful provision; they have become gradually filled by a deposit of new bony matter, perfectly solid and hard, but so

transparent that nothing but examination by actual contact could convince an observer that they were actually closed. This appearance is exceedingly remarkable, and exactly resembles the transparent layers which are seen in agatose pebbles, surrounded by a more opaque mass. The surface is uniform, even, and highly polished, and continues, without the least break, from one tooth to another. It extends at present to the bicuspid, is perfectly equal on both sides, and when the molars are closed the opening, by this loss of substance in front, is observed to be widest in the center, diminishing gradually and equally on both sides to the last bicuspid."

The same causes may be ascribed for this affection as for those of erosion and abrasion. There is apparently some constitutional acidity due to a gouty diathesis, the effect of which upon defective tooth-structures renders the central portions of the tooth-surface susceptible to both erosion and mechanical abrasion, and the latter process may account for the smooth and polished surfaces which are invariably present.

From the fact that teeth thus affected continue to lose structure much more rapidly than the unaffected teeth of the same mouth do from mastication, and this, too, even after they cannot be brought in contact with each other, we cannot ascribe the affection to mechanical abrasion alone.

Dr. Black remarks that "the effect is certainly that of erosion, and is identical with that process as seen on the labial surfaces of the teeth and occurring independently of mechanical abrasion."

The only treatment for such cases is that of restoration, either by means of capping with gold or the attachment of sections of porcelain crowns, as no local therapeutic treatment will control or arrest this singular disease.

MECHANICAL ABRASION OF THE TEETH.

Mechanical abrasion of the teeth is a process of attrition which results in a loss of substance, the progress of which depends upon the consistence of the tooth structures and the amount of friction to which the abraded tooth is subjected. Such a loss of substance is the result of imperfect articulation, the loss of masticating teeth, the nature of the food used, the action of hard substances upon natural teeth, such as porcelain teeth, the stems of clay pipes, the chewing of tobacco, etc., etc. Enamel and dentine, once formed, pass beyond the sphere of that reparative power found in other bony tissues where red blood circulates freely. New enamel is therefore never formed after the eruption of the tooth; and new dentine only within the pulp-cavity by the action of the odontoblasts.

The teeth rarely suffer much loss of substance from friction when the incisors of the upper jaw shut in front of those of the lower. It is only when the former fall directly upon the latter that mechanical abrasion of the cutting edges of the front teeth can take place, and when this happens, they sometimes suffer great loss of substance. The crowns of these teeth are occasionally worn entirely off, while those of the molars and bicuspid are, comparatively, little affected. The lateral motions of the jaw, being in these cases unrestricted—and this motion being, of course, greater at the anterior than at the posterior part of the mouth—it necessarily happens that the front teeth suffer the most abrasion. Sometimes all the teeth are worn off alike; at other times, owing to the peculiar manner in which the jaws come together, the abrasion is confined to a few.

Abraded surfaces of teeth often become very sensitive, and the irritation affects the dental pulp in such a manner as to often favor the deposit of secondary dentine, the site of the deposit corresponding to the abraded surface.

The rapidity of the abrasion depends greatly upon the manner in which the teeth antagonize, as sliding movements when the jaws are closed cause abnormal wear of the two surfaces. No doubt the grinding together of the teeth during sleep, the effect of nervousness, also facilitates the abrasion.

Abrasion is frequently caused by the loss of a number of teeth, which necessarily brings the entire work of mastication upon the remaining ones to such a degree as to rapidly wear them away, especially when the latter are few in number.

Mr. Bell believed that certain kinds of diet tend, more than others, to produce abrasion of teeth; in proof of which he referred to sailors who, the greater portion of their lives, live on hard biscuits, and have only a small part of the crowns of their teeth remaining. But the antagonism of the teeth has much more to do with it than the nature of the food; though, of course, when they do strike in such a way as to wear the cutting surfaces, very hard or gritty articles of food would make the abrasion more rapid.

When the front teeth of the lower jaw strike against the palatine surface of those of the upper, the latter are sometimes worn away more than three-fourths, and in some instances entirely upon the gums. We have seen the teeth of some individuals so much abraded in this way, that little of the crown remained, except the enamel on the anterior surface.

The wearing away of the crowns of the teeth would sooner or later expose the pulp, were it not that nature, in anticipation of the event, sets up an action by which layers of odontoblasts of the pulp resume

their functional activity, and a portion of the organ, or the entire mass of it, at times is transformed into secondary dentine. By this beautiful operation of the economy, the painful consequences that would otherwise result from the exposure of the pulp are wholly prevented.

Treatment.—The early correction of irregularities in the arrangement of the teeth, so that a proper antagonism of the teeth is secured, by which the cusps will fit into sulci of the opposing teeth, may be suggested as preventive treatment in many cases.

After the abrasion has occurred, the adaptation of caps of gold or other metal, or gold in the form of contour fillings, or enamel sections, to the cutting edges and grinding surfaces thus worn away, or the insertion of artificial masticating teeth, will often preserve and render useful teeth in such a condition, and prevent further abrasion.

FRACTURES AND OTHER INJURIES OF THE TEETH FROM MECHANICAL VIOLENCE.

The injuries to which teeth are subject from mechanical violence are so variable in their character and results as to render a detailed description impossible. The same amount of violence inflicted upon a tooth does not always produce the same effect. The nature and extent of the injury will depend as much upon the physical condition of the teeth, the state of the constitutional health, and the susceptibility of the body to morbid impressions, as upon the violence of the blow. Thus, a blow sufficiently severe to loosen a tooth might not, in one case, be productive of any permanent bad consequences; while in another it might cause the death of the organ and inflammation of the adjacent parts, as well as necrosis of the alveolus.

A tooth of compact texture, and in a healthy mouth, may be deprived of a portion of its substance without any serious injury; but a similar loss of substance in a tooth not so dense in structure would be likely to produce inflammation and suppuration of the pulp, and possibly of the peridental membrane. Hence, in order to form a correct opinion of the result of injuries of this sort, we must take into consideration not only the character of the tooth upon which the blow has been inflicted but also the state of the mouth and the health of the individual.

If the tooth is not loosened in its cavity any injury resulting from a loss of a small portion of the enamel, or even of the dentine, may be prevented by smoothing the fractured surface with a file or corundum disc or point, that the fluids of the mouth and particles of extraneous matter may not be retained in contact with it. But if the tooth is loosened and pulpitis or periodontitis has supervened, leeches should

be applied to the gums, and the mouth washed several times a day with some anodyne and refrigerant lotion, until the inflammation subsides. For more detailed treatment the reader is referred to the chapters on periodontitis and pulpitis.

When a tooth has been displaced from its cavity by a blow, and its vascular connection with the general system destroyed, necrosis is very prone to occur. An imperfect union between the tooth and alveolus may sometimes be re-established by the effusion of a coagulable lymph and the formation of an imperfectly organized membrane; but the tooth may after, from the slightest cold or derangement of the digestive organs, be liable to become sore to the touch, and in most cases will ultimately assume a discolored appearance.

The author has, on several occasions, replaced teeth that had been knocked from their cavities; and in some instances the operation was attended with success. The subject in one case was a healthy boy of about thirteen years of age, who, while playing bandy, received a blow from the club of one of his playmates, which knocked the left central incisor of the upper jaw entirely out of its cavity. He saw the boy about fifteen minutes after the accident. The alveolus was filled with coagulated blood. This he sponged out, and after having bathed the tooth in tepid water, carefully and accurately replaced it in its socket, and secured it there by silk ligatures attached to the adjacent teeth. On the following day the gums around the tooth were considerably inflamed, to reduce which inflammation he directed an application of three leeches and the frequent use of an anodyne and refrigerant lotion (solution of acetate of lead combined with tincture of opium). At the expiration of four weeks the tooth became firmly fixed in its cavity, but the tooth protruded somewhat, and slight soreness is experienced on taking cold (the result, no doubt, of the retention of a dead pulp.)

Numerous cases have occurred of replanted teeth which were properly prepared before re-insertion, by filling of pulp-canals after the removal of the dead pulp, becoming firmly fixed.

The alveolar processes and jaw-bones are sometimes seriously injured by mechanical violence. The author was requested by the late Dr. Baker, of Baltimore, to visit with him a lady who, by the upsetting of a stage, had her face severely bruised and lacerated. All that portion of the lower jaw which contained the six anterior teeth was splintered off, and was only retained in the mouth by the gums and integuments with which it was connected. The wounds of her face having been properly dressed, the detached portion of the jaw was carefully adjusted and secured by a ligature passed around the front teeth and first molars, and by a bandage on the outside, around the chin and back

part of the head. Her mouth was washed five or six times a day with diluted tincture of myrrh. The third day after the accident Dr. Baker directed the loss of twelve ounces of blood; and in five or six weeks, with no other treatment than the dressing of the wounds, she perfectly recovered.

It often happens that the crown of a tooth is broken off at the neck. We have known the crowns of four, and in some cases of thirteen, teeth to be fractured by a single blow. The subject of the last case was a fireman, who received an accidental blow on his mouth from the head of an axe, which broke off the crowns of all the upper and lower incisors, two cuspids, and three of the bicuspid of the inferior maxilla. The subject in the other case was a boy about twelve years of age, who, from a similar accident, occasioned by running up suddenly behind a man who was chopping wood, had the crowns of his upper incisors broken off. In both of these cases the inflammation which supervened was so great as to render the removal of the roots necessary. The crowns, roots, and alveolar processes are sometimes ground to pieces, or the teeth driven into the very substance of the jaw. Mr. Bell says he once found a central incisor so completely forced into the bone that he thought it to be the remains of a root; but, on removing it, found it to be an entire tooth.

When the crown of a tooth has been broken off by a blow, and destructive inflammation results, the root should be extracted. When, however, the injury has not been sufficient to cause such a degree of inflammation, an artificial crown may be engrafted on the root; but it is very necessary that the inflammation should be entirely subdued previous to the operation of crowning. If the tooth is to be replaced with an artificial substitute attached to a plate, the root should be first extracted, unless it is adapted to serve as a support for a section of bridge-work. In some cases, however, the root may be filled and be permitted to remain, but the practice is usually a bad one. The possibility of a fractured tooth reuniting was formerly doubted, but Wedl, in his "Pathology of the Teeth," refers to some fifteen cases in which union took place, some of which he ascribed to the formation of secondary dentine and others to that of cementum.

CARIES OF THE TEETH.

There is no affection to which the teeth are liable more frequent in its occurrence or fatal in its tendency than caries. It is often so insidious in its attacks and rapid in its progress that every tooth in the mouth may be more or less involved before even its existence is suspected.

Its presence is usually first indicated by an opaque or dark spot on the enamel, and if this be removed the subjacent dentine will exhibit

a black, dark-brown, or whitish appearance. It usually commences on the outer surface of the crown, at some point where the enamel is imperfect or has been fractured or otherwise injured, or on the surface of the dentine when this structure becomes exposed; from thence it proceeds toward the centre of the tooth, increasing in circumference until it reaches the pulp-cavity.

If the diseased part is of a soft and humid character the enamel, after a time, usually breaks in, disclosing the ravages the disease has made on the subjacent dentine. But this does not always happen; the form of the tooth sometimes remains nearly perfect until its whole interior structure is destroyed.

No portion of the crown or neck of a tooth is exempt from this disease; yet some parts are more liable to be first attacked than others; as, for example, the depressions in the grinding surfaces of the molars and bicuspid, the approximal surfaces of all the teeth, the posterior or palatine surfaces of the lateral incisors, and, in short, wherever an imperfection of the enamel exists.

The enamel is much harder than the dentine, and is by far less easily acted on by the causes that produce caries. It is sometimes, however, the first to be attacked, and when this happens the disease develops itself more frequently on the labial or buccal surface, near the gum, than in any other locality, often commencing at a single point, and at



FIG. 154.

* A transparent zone of dentine removed a short distance from and surrounding that which is undergoing decomposition consequent upon caries.

other times at a number of points. When the enamel is first attacked it is usually called erosion; but as this tissue does not contain so much animal matter as the subjacent dentine, the diseased part is often washed away by the saliva of the mouth, while in the dentinal part of the tooth it, in most instances, remains, and may be removed in distinct laminæ, after the earthy salts have been decomposed.

In very hard teeth the decayed part is of a firmer consistence and of a darker color than in soft teeth. Sometimes it is black, at other times of a dark or light brown, and at other times again it is nearly white. As a general rule, the softer the tooth, the lighter, softer, and more humid the caries. The color of the decayed part, however, may be, and doubtless is in some cases, influenced by other circumstances; perhaps by some peculiar modification of the agents concerned in the production of the disease.

Commencing externally beneath the enamel, the disease proceeds,

as before stated, toward the center of the tooth, destroying layer after layer, until it reaches the pulp, leaving each outer stratum softer and of darker color than the subjacent one.

The dentinal tubuli become less distinct near the margin of the carious structure than is the case in the perfectly normal tissue in proximity with the pulp-chamber, and, according to Mr. John Tomes, has a zone-like form (the zone of Tomes, Fig. 154), which he regards as a consolidation of the dentinal tubuli, an effort on the part of nature to place a line of demarcation between the healthy and carious structure.

Other writers, however, consider this zone of transparency to be the result of diseased action causing a complete exclusion of air from the tubuli, thus rendering them invisible when viewed by transmitted light.

The terms *deep-seated*, *superficial external* and *internal*, *simple* and *complicated*, have been applied to the disease. These distinctions only designate different stages of the same affection. By complicated decay is meant caries which has penetrated to the pulp-cavity of the tooth, accompanied by inflammation and suppuration of the pulp.

The roots of the teeth frequently remain firm in their cavities for years after the crowns and necks have been destroyed; but nature, after the destruction of the crowns, as if conscious that the roots are of no further use, exerts herself to expel them from the system, which is effected by the gradual wasting and filling up of their cavities. After this operation of the economy has been accomplished they are frequently retained in the mouth for months, and even for years, by their membranous connection with the gums.

Differences in the Liability of Different Teeth to Decay.—Having explained at some length, in a preceding part of this work, the manner in which the physical condition of the teeth is influenced, it will not now be necessary to dwell upon this portion of the subject. It will only be requisite to state, therefore, that teeth which are well formed, well arranged, and of a firm texture, seldom decay, and when they are attacked the progress of the disease is not rapid; whereas those that are imperfect in their formation and of a soft texture are more susceptible to the action of the causes which produce it; and when assailed, if the progress of the affection is not arrested by art, they usually fall speedy victims to its ravages. Just in proportion as the dentinal structure of the teeth is hard or soft, the shape of the organs perfect or imperfect, their arrangement regular or irregular, is their liability to caries diminished or increased.

The density, shape, and arrangement of the teeth are influenced by the state of the general health, and that of the mouth at the time of their dentinification and amelification. If at this period all the func-

tions of the body are healthily performed these organs will be compact in their structure, perfect in their shape, and usually regular in their arrangement. That the teeth should be thus influenced will not appear strange when we consider, as Richerand remarks, "that there exist amongst all the parts of the living body intimate relations, all of which correspond to each other and carry on a reciprocal intercourse of sensations and affections. Hence, if there is a morbid action in one part, other parts sympathize with it, rallying, as if sensible of the mutual dependence existing between them, all their energies to rescue their neighbor from the power of disease."

Increased action in one portion of the system is generally followed by diminished action in some other part; thus, for example, gastritis may be produced by constipation of the bowels; puerperal fever by diminished action in the heart, with an increased action in the uterus, etc. Hence, we may conclude that if the body at an early age be morbidly excited, its functions will be languidly performed, the process of assimilation checked, the regular and healthy supply of earthy matter in the bones interrupted, and, consequently, that the teeth which are then formed will be defective. Other parts of the body, in which constant changes are going on, if thus affected at these early periods, may afterward recover their healthful vigor; but if the teeth are badly formed they must ever, because of their low degree of vascularity, continue so; hence they will be more liable to decay than when dentinified under other and more favorable circumstances.

Capillary blood-vessels form a large part of every organ, the characteristic tissue of each being strictly *extra-vascular* (literally, *outside of the vessels*). Where the blood-vessels are most abundant, as in the nervous and muscular structures, growth and change take place rapidly and constantly, since almost every particle of the extra-vascular or interstitial tissue is in contact with the circulating fluid, the function of which is to supply material for growth and carry off waste matter. Hence such organs have great recuperative power and are modified by the varying conditions of the body. But the dentine and enamel of the teeth, when once formed, do not possess such a degree of vascularity as will restore carious tissues, although the pulp may deposit new structure in the form of secondary dentine as a barrier against its exposure.

Most writers are of opinion that the power of the teeth to resist the various causes of decay is sometimes weakened by a change brought about in their physical condition through the agency of certain remote causes, such as the profuse administration of mercury, the existence of fevers, and all severe constitutional disorders.

Severe constitutional disorders, and the administration of certain

kinds of medicine, may not act directly on the teeth by altering their physical condition, and thus rendering them more susceptible to the action of corrosive agents ; but they are indirectly affected in proportion as the secretions of the mouth are vitiated and their corrosive properties increased.

The formation, arrangement, and physical condition of the teeth are sometimes influenced by hereditary diathesis, affecting the parts concerned in their production or the general system. That a morbid condition of the system on the part of either parent often predisposes their progeny to like affections is an axiom fully recognized in pathology, and a fact of which we have many fearful proofs.

That there is an hereditary tendency in the teeth to decay cannot be denied. But we believe it to be the result of the transmission of a similarity of action in the parts concerned in the production of these organs ; so that the teeth of the child are, in form and structure, like those of the parent whom it most resembles, and from whom it has inherited the diathesis. The teeth of the child, if shaped like those of the parent, possessing a like degree of density, and similarly arranged, are equally liable to disease ; when exposed to the action of the same causes they are affected in like manner and usually at about the same period of life. Such being the fact, is it unreasonable to conclude that judicious early attention may so influence the formation and arrangement of the teeth that their liability to disease may be diminished ? Medicinal remedies and sickness have a powerful influence upon the dental tissues ; first, through hereditary transmission of an impaired constitution ; secondly, by their action upon the process of development, if given while the teeth are being formed. It is, then, to the differences in the physical condition and manner of arrangement of these organs—whether in different individuals or in the same mouth—that the difference in their liability to decay is attributable.

Dr. John Allen years ago remarked : “ The nutritious substances in the food that we take are intended to build up all parts of the system—the hard tissues as well as the soft tissues. Of the food intended to build up these organisms, certain portions make bone and teeth. Now the particles of matter are deposited atom by atom, and the system is gradually built up. When we take food into the system it is converted into blood. This blood is conveyed through all parts in little corpuscles, which are freighted with the proper constituents to sustain and build up these organisms. These little corpuscles convey such constituents as are necessary for the production of bone, teeth, flesh, and the fat, and these various substances are deposited just where they should be. Now it is essentially necessary that we have these little

vesicles freighted with the proper constituents, and duly freighted. How shall we know this? By taking the food just in the proportion that it is provided for us by our Creator and as it comes from nature's laboratory.

"Now we take this ground from the fact that, as a nation, we have worse teeth than any other on the earth. Now why is this? Simply because we change the proportions of these various constituents that our Creator has provided for us, by separating away what has been put there for the building up of the hard tissues.

"To prove this, let us look to other nations. They that do not change the proportions of the various constituents that enter into their bodies do not have decayed teeth.

"There is a constant change going on, and particles of matter are deposited atom by atom, and the system kept fully charged with the mineral elements of which these structures are built up. When you look at nations that do not change the proportions, you see no decayed teeth, and the history of these nations proves that their teeth are sound and beautiful to old age. What is the condition in our country? We *do* change these proportions. We *do* ignore the mineral elements provided for us, and we *do* have decayed teeth. We find that there are over twenty millions of teeth swept from our population every year. We do not take the material into our system that carries back, atom by atom, and keeps the hard tissues built up until the old particles pass away. The old particles pass away after they have served their purpose, and new ones then take their places.

"It is estimated that every child uses half a barrel of flour every year; and it is estimated that there are forty pounds of the bone-forming material thrown out from every barrel that we use. The child takes its food on fine flour, and is deprived of twenty pounds in a year of this mineral element, which should be taken into the system in order to make those hard, flinty substances that our Creator intended. Now, by the time that child is twenty years of age it has been deprived of four hundred pounds of the elements which should have been taken into the system, and would have kept it charged sufficiently to have preserved these substances hard and flinty, as they should be.

"We sweep from our American population over twenty millions of teeth every year, and this should prove the theory that our tissues do undergo a change, and that, particle by particle, they pass away. As it is now, the teeth are becoming worse and worse every year; and not only this, but it becomes hereditary, and is transmitted from parent to child."

Predisposing Causes of Dental Caries.—The causes of dental caries are divided into predisposing and exciting; among the former may be

enumerated a defective constitution, either innate in the child as derived from the parent, or acquired from accidental influences to which the child has been exposed. Any condition of the system that will interfere with the proper elimination and application of the materials necessary for the formation of perfect structures may have a deleterious influence upon the teeth. Hereditary defects are quite common, the teeth of the child exhibiting the peculiarities of those of the parents. Impaired or diminished vitality from constitutional or local causes is also a predisposing cause of dental caries. Febrile conditions not only impair or diminish vitality, but change the nature of the fluids of the oral cavity to such a degree as to cause them to act upon the teeth very injuriously. Dr. George Watt remarked that "all diseases tend to weaken the dental organs, and thus are predisposing causes of decay. The most virulent are the *eruptive fevers*, such as typhus, typhoid, and scarlet fevers, measles, smallpox, erysipelas, etc. These fevers, and perhaps all diseases, predispose to decay in two ways. Weakening the entire constitution, they correspondingly impair the vitality of the teeth, and thus they have less power to resist the encroachments of the exciting causes of decay. And further, they deprave the secretions of the salivary glands and the oral cavity, rendering them liable to such decomposition as will result in the formation of exciting causes. That the condition of the teeth is influenced by heredity, no observing dentist can doubt. We have seen a family in which its female members, for four generations, lacked the left upper lateral incisor. Sometimes one parent has good teeth, and good dental organs pertain to the family history, and the case with the other parent is just the reverse; we see children not usually having dental organs of an average between the two parents, but some of them copying one parent and some the other. The constitution of the parents, and especially that of the mother, may be unable to impart due vigor or proper materials in requisite quantities to the process of developing the teeth. From some cause, hereditary or otherwise, there may be a lack of lime salts in the system, or a lack of physiological ability to appropriate them and build them in properly with the organic matter of the teeth. Another condition may show the very best formed teeth while the alveolar processes, periosteum, and mucous membrane may be defective. A defective periosteum cannot give efficient nutrition; deficient development of the alveoli results in ineffectual support; while if anything is wrong with the mucous membrane we may have to contend with defective or depraved secretions." Dyspepsia affords an example of both a predisposing and an exciting cause of caries, as its effect is to generate an acid in the stomach which, by eructation, is brought into direct contact with the teeth. Malaria is a predisposing cause of dental caries,

on account of the unfavorable conditions it induces; also such medicinal agents as vitiate the oral fluids and irritate the mucous membrane and periosteum, and interfere with the functions of the mucous follicles and salivary glands—mercury, for example; also salivary calculus, by its irritating effects upon the soft tissues in connection with the teeth and its influence upon the oral secretions; also want of exercise, which affects the stability of the teeth and causes absorption of the alveoli; also want of cleanliness, which may be regarded as one of the most common of the predisposing causes of dental caries; also artificial teeth improperly inserted or composed of bad materials; also improper dental operations, both as regards manner and time; also diseased teeth and roots, which are productive of irritation to the peridental membrane and gums; also sudden changes of temperature, which may cause an exalted sensibility of the dentine, diminish the vitality of the teeth, or produce checks in the enamel of frail teeth.

The fissures and grooves on the crowns of the molars and bicuspid are ascribed by some to an arrest of development, a failure of the enamel covering in its formation from the cusps toward the center of the crown to come together and coalesce. Others, however, ascribe these defective places to be due to a rupture of the enamel organ at these points—a separation of the ameloblastic layer, thus separating the enamel rods and forming a fissure; such fissures being more common in teeth with prominent cusps.

Exciting or Immediate Causes.—The exciting or immediate cause of dental caries is conceded to be the action of agents chemically disintegrating the hard structures of the teeth, and which have their source in the vitiated secretions of the mouth, abnormal secretions from the stomach, the saliva, the mucus, and the decomposition of animal and vegetable substances. The theory that the decay of the teeth is the result of the action of external agents was first distinctly suggested to the dental profession of the United States about the year 1821, by Drs. L. S. and Eleazer Parmly. The late Professor Westcott, by a series of experiments made in 1843, found that “acetic and citric acids so corroded the enamel in forty-eight hours that much of it was easily removed with the finger-nail, and malic acid or the acid of apples, in its concentrated state, also acts promptly upon the teeth. Dr. W. D. Miller, an American dentist practicing in Berlin, deserves great credit for many careful investigations made to determine the cause of dental caries. He has given the results of over three hundred experiments, and has cultivated bacteria in order to determine the nature of a new fungus which is always found in the mouth and in carious dentine, and which is said to be always accompanied by a strong acid. Dr. Miller maintains that caries are caused either by the casual intro-

duction of strong acids into the mouth or by the weaker acids formed by the fermentation of farinaceous or saccharine particles of food. After the destruction of the enamel, the process of disintegration attacks the organic matter, and first of all the micro-organism, which causes an endless variety of changes in the dentine, until finally it presents the appearance of a mass of decomposed matter intersected in every direction with fungi. Dr. Miller asserts that he has been convinced, by an examination of several hundreds of specimens, that after decalcification has taken place, the only change of any importance which occurs is produced by micro-organisms. And he further says that he sees "the need of little or nothing more than organic acids and fungi



FIG. 155.—LONGITUDINAL SECTION OF A CARIOUS BICUSPID.

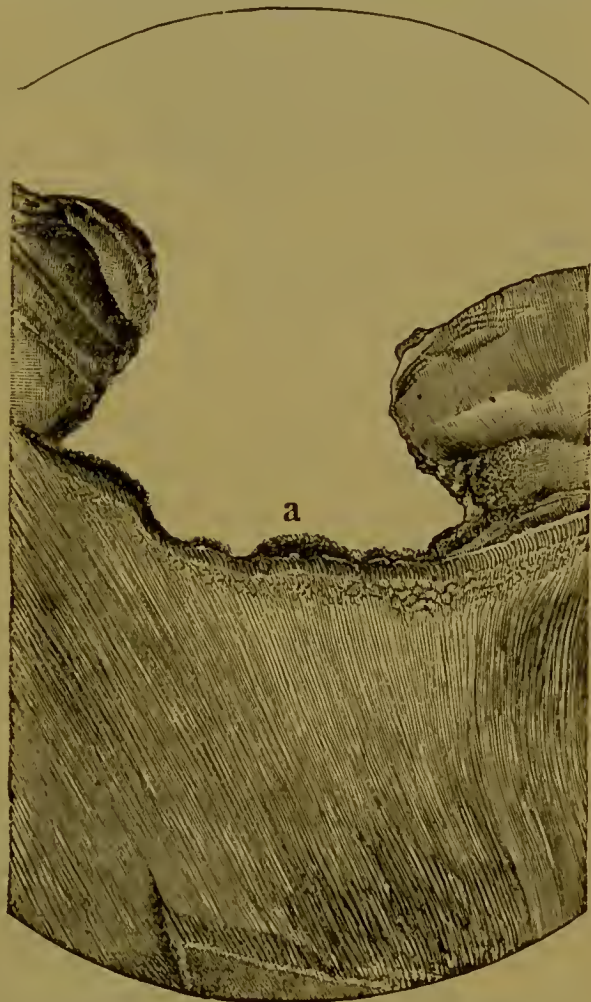


FIG. 156.—UNDERMINING ENAMEL DECAY.
a. Masses of Bacteria Lining the Cavity. Magnified about 50 Diameters.

to account for all the phenomena of dental caries." "Give me these two factors and I can produce caries which will deceive the most experienced operators and microscopists."

Dr. Miller sums up in the following propositions the results of his investigations on the subject of dental caries:—

First. The contact of saliva with amylaceous or saccharine food (not to speak of nitrogenous food), or a solution of sugar or starch in saliva, kept at body temperature, invariably gives rise, in four or five hours, to a strong acid reaction, due to the generation of an organic acid.

Second. There must consequently be in the human mouth a constant, though variable, generation of acid, because of the impossibility of keeping the mouth perfectly free from food and from solutions of amyloids in saliva, which penetrate cracks, pits, and fissures, or are held by capillary attraction between the surfaces of the teeth in contact and there become acid by fermentation.

Third. The degree of acidity depends somewhat upon the length of time which has elapsed since partaking of food, and will be found greatest on rising in the morning.

Fourth. A cavity of decay in which saccharine or amylaceous food has remained for some hours must and will be found, always and without exception, to have an acid reaction.

Fifth. The extent to which any tooth suffers from the action of the acid depends upon its density and structure, but more particularly upon the perfection of the enamel and the protection of the neck of the tooth by healthy gums. What we might call the perfect tooth would resist indefinitely the same acid to which a tooth of opposite character would succumb in a few weeks.

Sixth. An occasional possible absence of an acid reaction in a cavity of decay is no indication that acid has not participated in the production of the cavity. Little or no value can be attached to tests of the saliva alone.

Seventh. Any general or special disorder or condition of the system which results in the withdrawal of lime salts from a tooth, or in a lowering of its density, or in a weakening of the chemical union between the organic and inorganic matter of the tooth, renders it more liable to decay.

Eighth. Strong acid and corroding substances brought but momentarily into the human mouth may give rise to lesions of the enamel at points where the ordinary agents alone could never have begun.

Ninth. All the microscopic appearances and characteristics of caries may be produced with the greatest exactness *out* of the mouth, simply by subjecting teeth to those acid mixtures which are constantly to be found *in* the mouth.

Tenth. The superficial layers of carious dentine undergo an almost if not absolutely complete decalcification, which decreases as we approach the normal dentine. The same is true of dentine decalcified in saliva and bread.

Eleventh. The destruction of the organic constituents follows (not precedes) the decalcification, and is evidently, for the most part, to be ascribed to the action of fungi.

Twelfth. The fungi found in the human mouth do not participate *directly* in the process of decalcification. The exact part which they

perform in the production of an acid reaction requires further investigation.

Thirteenth. The fungi produce the most manifold anatomical changes in the softened dentine, resulting in the complete obliteration of the structure and final disappearance of the tissue in a mass of debris and fungi.

Fourteenth. The invasion of the micro-organisms is always preceded by the extraction of the lime salts.

Fifteenth. The destruction of the tissue remaining after decalcification is effected almost wholly by fungi alone.

Sixteenth. Inflammation can hardly be looked upon as a very important factor in caries of the teeth.

Seventeenth. Caries of the enamel is purely chemical, the decalcification resulting at once in the complete dissolution of the tissue.

Eighteenth. Caries of cement runs a course analogous to caries of dentine, a softening of the tissues by acids, and following this its destruction by fungi; a slight inflammatory action on the part of the living matter in the corpuscles is not to be excluded.

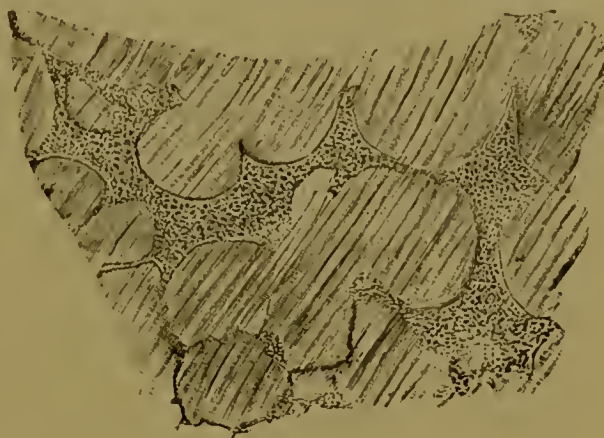


FIG. 157.—INTERGLOBULAR SPACES FILLED WITH MICROCOCCI.

Magnified about 400 Diameters. (Bödecker.)

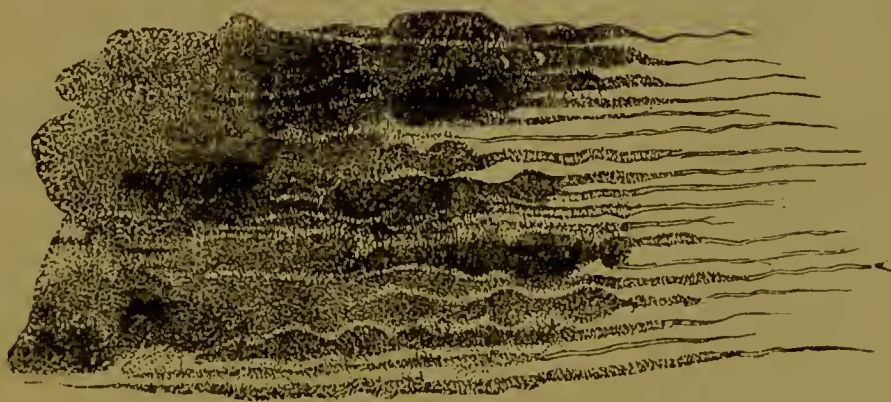


FIG. 158.—DECAYED DENTINE.

Showing total liquefaction of the basis-substance by bacteria. Magnified 400 diameters. (Bödecker).

Dr. Frank Abbott, after a careful investigation of the etiology of dental caries, concludes that the first lesion is due to the action of an acid, which in a merely chemical way dissolves out the lime salts from the enamel, and that such an acid is generated from the decaying material found in the food, mainly in such kinds of foods as through their decomposition are apt to produce an acid possessing a

high degree of affinity for lime salts, viz.: lactic acid. He also believes that the organic portion of teeth, as it advances to the stage of decomposition in the process of caries, plays a very important part in the formation of this acid; and that perhaps the sour decomposition is assisted locally by the action of micrococci and leptothrix, and he concurs with the views of those who claim that the resistance of the teeth against caries, owing to their amount of lime-salts, greatly varies in different people; that on a dead tooth, natural or artificial, as well as on teeth made from the dentine of the elephant or the hippopotamus, the process will remain under all circumstances a chemical one, assisted only by the putrefying remains of the organic material of the tooth; while on a live tooth either acute or chronic reaction changes take place. Dr. Abbott sums up the results of his researches as follows: "I. In enamel, caries in its earliest stages is a chemical process. After the lime salts are dissolved through the inflammatory reaction, and the basis-substance liquefied, the protoplasm reappears and breaks apart into small, irregularly shaped, so-called medullary or embryonal bodies, and subsequently the lime salts are dissolved by acids or washed away. II. Caries of dentine consists of a dissolution of the lime salts in the intertubular substance by the inflammatory reaction, a melting down of the glue-yielding basis substance (matrix) around and between the canaliculi. The living matter contained in the canaliculi proper is transformed into nucleated protoplasmic bodies, which, together with protoplasmic bodies originating from the living matter in the basis-substance, form the so-called indifferent or inflammatory tissue. III. Caries of cement exhibits first all phenomena known to be present in the early stages of inflammation of bone. The protoplasmic cement-corpuscles, together with the basis-substance, after its liquefaction, produce indifferent or inflammatory elements. IV. The indifferent elements originating through the carious process from enamel, dentine, and cement do not proceed in new formation of living matter, but become disintegrated and transformed into a mass crowded with micrococci and leptothrix. V. Caries of a living tooth, therefore, is an inflammatory process, which, beginning as a chemical process, in turn reduces the tissues of the tooth into embryonic or medullary elements, evidently the same as during the development if the tooth have shared in its formation; and its development and intensity are in direct proportion to the amount of living matter which they contain, as compared with other tissues. VI. The medullary elements, owing to want of nutrition and to continuous irritation, become necrosed, and the seat of a lively new growth of organisms common to all decomposing organic material. VII. Micrococci and leptothrix by no means produce caries; they do not penetrate the cavities in the

basis-substance of the tissues of the tooth, but appear only as secondary formations, owing to the decay of the medullary elements. VIII. In dead and artificial teeth caries is a chemical process, assisted only by the decomposition of the glue-yielding basis-substance of dentine and cement."

Dr. Abbott, therefore, does not consider micro-organisms as the primary cause of caries of the teeth. Dr. Miller, on the other hand, believes that the invasion of micro-organisms is the only cause of dental caries, and that the living tissues are destroyed by the micro-organisms without reacting upon the injury—in other words, without any inflammatory reaction whatsoever in the affected hard tissue of the tooth. Dr. Bödecker, however, believes that the full truth in regard to the carious process can be established only by a combination of both Abbott's and Miller's assertions, and further remarks:—"I admit that micro-organisms are the principal cause of the decay of teeth; but only *dead* material will be destroyed by them without the least reaction. Living tissue—*i. e.*, enamel, dentine, and cementum—invariably react upon the invasion of the micro-organisms by an inflammatory process similar to that in other living tissues in the manner described by Abbott."

Prevention of Caries.—It is an old adage, no less true than trite, that "an ounce of prevention is better than a pound of cure," and in the present instance it may be applied with its full force. Were more attention paid to the practical instruction thus conveyed, many of the diseases of the teeth might be avoided. Most of the remarks that might be made on this subject have been anticipated, consequently it will only be necessary to observe that if the teeth are well formed and well arranged all that will be required is to keep them clean; if any irregularity occurs it should be remedied by the means to be described.

For cleansing the teeth, when they are in a sound condition and free from calcareous deposits, the gums healthy, and the secretions of the mouth normal in character, the regular and frequent use of pure water by means of a proper brush and waxed floss silk will, in most cases, be sufficient. But when the enamel is stained and discolored and the secretions of the mouth inclined to acidity, with a tendency to calcareous deposits, then the employment of a dentifrice is necessary.

Dentifrice—from *dens*, a tooth, and *frico*, *fricare*, to rub—is a medicinal preparation, in the form of a powder, for cleansing the teeth. An almost numberless variety of dentifrices are in use, and many of them highly injurious. In the preparation of an agent of this kind the object should be to obtain a compound pleasant to the taste, altogether free from acids and acrid substances, and soluble or insoluble,

according to the nature of the case in which it is to be used—one capable of neutralizing and removing acrid and fermenting matters secreted between the teeth and also allaying irritation. A dentifrice, then, should be anti-acid and, moreover, a powder; and the more simple the preparation the better. A preparation composed of orris root, prepared chalk, and pure Castile or white Windsor soap, to which may be added very finely-powdered cuttle-fish bone or pumice-stone, for the removal of calcareous matter when there is a tendency to deposits of this nature, will answer every purpose. When the gums are in a healthy condition there is no use for such ingredients in a dentifrice as Peruvian bark or myrrh, and as for liquid dentifrices, they are of very little use, for the object in using the brush is friction, and as these liquid preparations are generally lubricating alkaline substances, they cause the brush to pass so easily over the teeth as to render them almost useless. In many cases an unhealthy condition of the gums is owing to the irritation produced by local irritants, and their removal is all that is needed to restore them to health. Soap alone will not cleanse the teeth, for it prevents friction; and charcoal, notwithstanding its detergent and antiseptic properties, is injurious as a dentifrice or as an ingredient of one, on account of its insinuating itself under the free margin of the gum and causing it to recede from the neck of the tooth, no matter how finely it may be pulverized. Either of the following dentifrices may be used:—

℞.	Prepared chalk,	℥ iv.
	Powdered orris root,	℥ iv.
	Powdered cinnamon,	℥ iv.
	Sup. carb. of soda,	℥ ss.
	White sugar,	℥ j.
	Oil of lemon,	gtt. xv.
	Oil of rose,	gtt. ij.
or		
℞.	Prepared chalk,	℥ ij.
	Powdered orris root,	℥ ij.
	Pumice stone,	℥ j.

Ingredients in both prescriptions to be thoroughly pulverized and well mixed.

The importance of keeping the teeth clean cannot be too strongly impressed upon the mind of every individual. Proper attention to the cleanliness of these organs contributes more to their health and preservation than is generally supposed. Against caries it is a most powerful prophylactic. “When the teeth,” says Dr. L. S. Parmley, “are kept literally clean, no disease will ever be perceptible. Their structure will equally stand the summer’s heat and winter’s cold, the changes of climate, the variation of diet, and even the diseases to

which the other parts of the body may be subject from constitutional causes."

The configuration and arrangement of some teeth is such, however, as to preclude the possibility of keeping them clean; but this should not deter any one from using the proper means, for if disease is not wholly prevented they will, at least, contribute very greatly to the preservation of the organs.

The subject of "food in relation to the teeth" has claimed the attention of eminent writers, many of whom are convinced that strict attention on the part of the mother to hygienic laws, from the time of conception, will influence for good the structural quality of the developing tooth-tissues of the child. As phosphate of lime is an important ingredient of the tooth-tissues, it is urged that the requisite quantity of this lime salt should be supplied with the food, and that due attention to the laws of health in regard to exercise, rest, ventilation, bathing, etc., will cause the lime salt to be assimilated and properly appropriated in the formation and development of tooth-tissues. Many also believe that foods prepared by artificial means are very serviceable in supplying such elements as fail to be assimilated in the ordinary manner; hence the use during pregnancy and lactation of preparations of the syrup of the lactophosphate of lime, wheat phosphate, and such articles of diet as oatmeal, cracked wheat, etc., are recommended as being of great benefit. No doubt the amount of phosphate to be used by the system will depend, in a great measure, upon the digestion.



